AGRICULTURAL RESEARCH INSTITUTE

PUSA

THE

MALAYAN AGRICULTURAL JOURNAL.

VOL. X.

JANUARY—DECEMBER, 1922.

KUALA LUMPUR

PRINTED BY HUXLEY, PALMER & COMPANY, LIMITED

1924.

THE

Malayan Agricultural Journal.

Vol. X. JANUARY, 1922. No. 1.

EDITORIAL NOTES.

STAFF.

THE post of Director of Agriculture has been abolished and the head of the Department of Agriculture is now styled Secretary for Agriculture, S.S. and F.M.S.

Mr. A. S. Haynes is acting as Secretary for Agriculture, and Mr. L. Lewton Brain formerly Director of Agriculture is appointed to the new post of Technical Adviser (G. N. 2090—7-1-22). Correspondence with the Department should be addressed to the Secretary for Agriculture.

INVENTIONS.

It is thought that notes on inventions, connected with rubber or other agricultural products which are patented in Malaya from time to time, may be of interest to readers. These notes will be included in "Chemical Notes" and will contain information on new processes published in other journals which are considered to be of value and local interest.

RUBBER INVESTIGATIONS.

Notes and criticisms on rubber investigations carried out in other countries will also be included in the Bulletin.

MARKET PRICES.

Information in respect of market prices of agricultural products already grown or suitable for local cultivation, will be published quarterly. The London and American quotations will be included, if available. Suggestions will be welcomed in respect of any product which it is considered might be included.

SPOTTING OF RUBBER.

Samples of smoked sheet were received for investigation; these showed opaque patches when held up to the light, and were badly mottled in consequence. This is the first case of "Spotting," on smoked rubber recorded in this Department. The trouble was proved to be organic by sterlising the latex as completely as possible, when the resulting sheets were prepared quite clean.

CINCHONA.

During January the Assistant Economic Botanist spent three weeks in the chief Cinchona district of Java for the purpose of obtaining information concerning the Cinchona industry there.

MARKETS.

A London merchant, whose name and address will be supplied on application to the office, asks to be placed in touch with some firm or individual who can supply him with Kapok and Raw Cotton. (Reference No. D. A. 389/22).

Several enquiries have been received from other firms also who are interested in buying Kapok.

If producers of Kapok write to the Secretary for Agriculture quoting as a reference D. A. 908 –1922, they will be put in touch with the enquirers.

SMALL RICE MILLS FOR ESTATES

The attention of estate managers and others is drawn to the advantage which would result from installing small power mills on their estates to mill rice for the use of their coolies.

A small and inexpensive machine is the Engelberg Rice Huller which is in use on one estate and which works very well. Messrs. Guthrie & Co. are agents for the machine, which was exhibited at the Malaya-Borneo Exhibition in Singapore. It can be run by the power used in connection with rubber factories. In those parts of the country where the padi-planters have padi for sale (this applies particularly to the Krian district and to Province Wellesley) the estate manager could buy padi in bulk from the padi planter direct without the intervention of any middle man and without all the charges incidental to transporting the padi oversea from another country; and probably arrangements could be made for padi, either parboiled or not, to be sold by the Government Rice Mill at Bagan Serai.

The buying of local padi, parboiled or non-parboiled, and the hulling of it by estate managers would, apart from advantages to the buyer, bring great benefit to this country; by creating a market for padi it would encourage padi cultivation and it would at the same time keep in this country money which now goes into the pockets of padi-planters and others outside the country.

A further advantage is that the coolies who eat the non-parboiled polished rice will here find a substitute grown in the country, hulled by their own employers and free from the danger of beri-beri which goes with the use of the highly polished imported rice. The greater the demand for this local rice, the more encouragement padi-planters will have for increasing the supply by more planting. The question of polished rice and beri-beri was discussed at the meeting of the Planters Association of Malaya held at Penang on 27th February, 1922, and it will be seen that an increase in the use of our locally-grown Malay rice on estates will greatly help towards a solution of the question which every employer of labour must have at heart. At the meeting it was stated that "in the cause of humanity and the labour force the question could not be allowed to rest". It is to be hoped therefore that every single employer who can do so will contribute towards the most natural solution of all, the growing by Malaya of its own rice supply, by buying the locally-grown padi where possible and hulling it on his own estate.

Those interested can address enquiries to the Secretary for Agriculture, Kuala Lumpur. (Ref. No. D.A. 416/22).

THE DWARF COCONUT IN MALAYA.

By H. W. Jack and W. N. Sands.

THE dwarf coconut, known in Malaya as the "nyior gading" has aroused much interest and criticism since Mr. W. P. Handover endeavoured to exploit it commercially in the pages of the Agricultural Bulletin, F. M. S. Vol VIII No. 3. Mr. Handover, in his article, stated that diligent enquiry was unsuccessful in tracing the origin of this dwarf race but that in his opinion the first palm occurred as a sport or mutant in Java, since scattered trees were found throughout Java and Sumatra, whilst reliable reports from India and Ceylon indicated that this variety was practically unknown in those countries. Furthermore, most of the oldest palms growing in Malaya, namely those in the Krian district of Perak, many of which are over thirty years old, appear to have been derived from fruits brought over from Sumatra or Java by the Banjanese rice-settlers and are therefore not of local origin.

Other apparently distinct dwarf races are known to be found in the Philippines, Java, Madagascar, Ceylon, the Maldive and Nicobar Islands but, according to Handover, only the Nicobar dwarf and the "coco nino" of the Philippines appear to resemble the 'nyior gading.'

The "King" coconut which is often referred to as being identical with the 'nyior gading' of Malaya was reported to Handover as having a thin gelatinous meat, useless for the manufacture of copra and slow in coming into bearing.

In order to verify this report, fruits of the "King" coconut were obtained from the Ceylon Department of Agriculture for examination which revealed the fact that this dwarf coconut was quite distinct from the "nyior gading" but closely resembled the dwarf type known to the Malays as the "puyoh." Dr. Boldingh of the Department of Agriculture, Java, is of opinion that more than one variety of dwarf coconut may be known as the "King" in Ceylon because fruits which he obtained some time ago from that Island appeared to be different from the type examined and described below. The characters of what appeared to be typical fruits of the "King" and 'nyior gading' varieties are compared below:

Characters of dry fruit.	Nyior Gading.	King	Remarks.
Shape of fruit	Ovoid ...	Ovoid ...	The King fruit is narrower than the "nyior gading."
Apex of fruit ...	Slightly sunken and "eye" small	Full and "eye" prominent	
Length of fruit ...	$7\frac{3}{4}$ inches	$7\frac{3}{4}$ inches	
Circumference (equatorial)	$20\frac{1}{2}$,,	18 ,,	
Greatest thickness of husk (exocarp)	$2\frac{1}{2}$,,	$2\frac{1}{4}$,,	
Thinnest part of husk ...	2/5 ,,	$\frac{1}{2}$,,	
Thickness of shell of nut (endocarp)	1/10-1/5 in.	1/8-1/4 in	The King nut is slightly longer than the "nyior gading" and is quite different in shape.
Length of nut	$4\frac{1}{4}$ inches	$4\frac{1}{2}$ inches	
Greatest width of nut ...	$4\frac{1}{2}$,,	$3\frac{3}{4}$,,	
Thickness of meat (endosperm)	$\frac{1}{2}$,,	7/16 ,,	Meat firm, but thinner than in the "nyior gading."

Fruits of the "coco nino" were obtained from the Philippines and examination showed them to be much smaller than the "nyior gading" in every respect and differing in shape and the character of the apex. The nut characters resembled those of the "nyior gading" in shape only. It is almost certain therefore, that this coconut is not identical with the local variety unless the fruits obtained for examination were derived from trees growing under particularly unfavourable conditions, which is unlikely since they were said to have been collected in the best coconut growing district in the Philippines. The writers have not yet had an opportunity of studying the characters of tho Nicobar dwarf, but fruits obtained from Sarawak under the name "nyior kapal" certainly resemble the local "nyior gading" and will probably be found to belong to the same race. The Superintendent of Land and Surveys, Kuching, Sarawak, was unable to give any reliable information regarding the origin of the "nyior kapal" but mentions that it is certainly not indigenous and was unknown in

PLATE 1.

Sarawak not very many years ago. It is not planted there commercially, but is usually grown in the vicinity of houses. According to native reports, the coconut was first introduced into the country by the first Datoh Bandar who brought some nuts (plants?) with him on his return from Mecca some 80 years ago. They were called 'nyior kapal' because the Datoh stated that the palms were growing in tubs on the ship on which he took his passage to and from Jeddah.

It is unfortunate that the place and date of the first occurrence of the interesting and valuable ivory-yellow coconut are not known. Judging from observations and the evidence of local growers, it would appear to be a mutation from the tall or common form due to some change in the hereditary units or genetic factors. Evidently the change in a factor (or factors) which leads to the production of a palm with such pronounced size-differences from the normal type, takes place at rare intervals in the coconut, still it is of interest to note that dwarf types do occur where large areas of coconuts exist, and in widely distributed places.

Although no experiments along Mendelian lines have been made so far, we should expect to find that the Malayan dwarf form is a recessive mutant with perhaps only a single factor concerned, but as Dr. W. Bateson pointed out in his Croonian lecture of 1920, merely quantitative differences, for example those relating to size and height, seldom, if ever, have a perfectly simple inheritance.

There are several colour variations of this dwarf coconut such as yellow, green, red and intermediate shades of these colours, so that it is difficult to express an opinion as to which particular type is like the first mutant and which forms are the result of further mutations.

As a detailed description of the "nyior gading" has already been given by Handover in his article and in other publications there is no need of repetition in these notes. The photograph plate I, however, shows typical fruits and illustrates how closely they resemble each other; Y—the ivory-yellow type, R the red (apricot); G green. The measurements of the various parts of each are also very similar as the following table shows:

Characters of Fruit	Ivory-yellow	Red (apricot)	Green.
Length of fruit	$7\frac{3}{4}$"	8"	$7\frac{3}{4}$"
Circumference of fruit ...	$20\frac{1}{2}$"	21"	21"
Greatest thickness of husk (exocarp)	$2\frac{1}{2}$	$2\frac{1}{2}$"	$2\frac{3}{4}$"
Thinnest part of husk ...	2/5	3/10	1/5
Thickness of shell of nut (endocarp)	1/10-1/5"	1/10-1/5"	1/10-1/5"
Length of nut	$4\frac{1}{4}$"	$4\frac{1}{4}$"	4-2 5
Greatest width of nut ...	$4\frac{1}{2}$"	$4\frac{1}{4}$"	$4\frac{1}{2}$"
Thickness of "meat" (endosperm)	$\frac{1}{2}$"	$\frac{1}{2}$"	$\frac{1}{2}$"

In the extensive plantations in the Port Dickson district, the mixed charatcer of the palms is an unsatisfactory feature. Although the dwarf-yellow, the variety desired, predominates, other dwarf coloured forms, semi-talls and talls occur at intervals throughout. This admixture of varieties is no doubt due, in part, to the fact that, in planting these areas, a very large number of fruits had to be obtained from various sources, and it was not always possible to ascertain difinitely whether each fruit had been obtained from a typical dwarf ivory-yellow palm. It is quite evident that natural crossing take place between the tall and dwarf races, so that the semi-talls, or intermediate forms, which occur, are probably first generation hybrids betwe n the talls and dwarfs. The talls may also be hybrids, but we are inclined, at present, to regard them as pure dominants, which have segregated out in the second generation of a cross between the two races, and therefore the progeny of fruits collected from semi-tall forms. Careful breeding experiments, however, would be likely to clear up many of the doubtful points connected with the inheritance of these quantitative and colour characters.

The dwarf ivory-yellow variety is said to give 80% of plants true to type, even when fruits are collected in "kampongs" from palms growing in association with other varieties and open to cross-pollination.

In order to establish fields of dwarf coconut varieties at the Experimental Coconut Plantation at Sapintas, a large number of fruits was obtained from Sungei Nipah Estate, and sown on December 29th 1920.

The results obtained up to June 15th, 1921, are as follows: –

Dwarf Variety.	Number sown.	Number germinated.	Number true to type.	Number not true to type.
Ivory-Yellow	500	422	406 or 96.2%	16 or 3.8%
Green ...	570	434	298 or 68.7%	136 or 31.27%
Red ...	200	126	94 or 74.6%	32 or 25.4%

The high percentage, namely 96.2% of the ivory yellow variety which appeared to be breeding true, is a striking feature, and this notwithstanding that other varieties occur in the Sungei Nipah Plantation and the flowers were not artificially self-pollinated.

The colour characters of three of the principal strains of dwarf race grown locally are as follows.

IVORY-YELLOW: Petiole or stalk of leaf, *yellow;* petiole of youngest leaves *greenish-yellow*, usually closely covered with a brown felt of tufted hair which is quickly rubbed off as the leaflets expand; leaflets lighter green than other types. Young spathe *ivory-yellow.* Main stalk or axis of inflorescence and branches *ivory-yellow.* Floral leaves or perianth

PLATE 2.

segments of male and female flowers *ivory-yellow*. Fruit *ivory-yellow* to *yellow* before it starts to dry.

GREEN: Petiole of leaf *green*; petiole of youngest leaves, under hairs, *green*; leaflets *dark-green*. Young spathe *green*. Main stalk of inflorescence *greenish-yellow*; also the branches and perianth segments of the male and female flowers. Fruit *green* before drying.

RED: Petiole of leaf *warm-yellow*, darker than the ivory-yellow type. Young spathe *reddish*. Main stalk and branches of inflorescence *apricot* colour, as well as the perianth segments of the male and female flowers. Fruit *reddish-yellow* or *apricot* before drying.

It will be seen that, in each type, the colour of the petiole of the leaf corresponds fairly closely to that of the inflorescence and fruit. The colour differences of each dwarf can be seen quite clearly in the young leaves of the germinating nuts, and it is this fact which will aid the planter most materially in separating the different types in the nursery before planting them out. There remains, however, the problem of separating the dwarfs from the semi-tall and talls, which may possess similar colour correlation. Whilst this might present some difficulty, yet if sown about the same time, the shorter leaves of the dwarfs, compared with longer and larger leaves of the "semi-talls" and the still longer and larger leaves of the "talls," will enable a fairly accurate assortment to be made before removal.

Of course there may be fruits whose germination is retarded and others which produce poorly developed shoots; these features will add to the difficulty of making a perfect separation of the various types, but by closely studying the characters above described much purer "stands" of young plants can be obtained than are usual to-day.

In the photograph, Plate 2, are shown young plants of the dwarf ivory-yellow, red and green forms. The fruits were sown on December, 22th 1920. And on June 22nd, 1921, the colour and growth characters of the plants were recorded as under:--

IVORY-YELLOW: Number of leaves expanded *five*; length of longest open leaf, (the fifth) 2 feet 9 inches from base to tip. Colour of petioles of leaves *yellow*. Colour of rudimentary sheating leaves *yellow*.

RED: Number of leaves expanded *five*; length of longest leaf, (the fifth) 2 feet 9 inches from base to tip. Colour of petioles of leaves *warm-yellow*. Colour of rudimentary sheathing leaves *warm-yellow*.

GREEN: Number of leaves expanded *five*; length of longest leaf, (the fifth) 2 feet 10 inches from base to tip. Colour of petioles of leaves *green*.

Green ; Number of leaves expanded *five* ; length of leaf, (the fifth), 2 feet 10 inches from base to tip. Colour of petioles of leaves *green*, but rather lighter than that of the petioles of the expanded leaves.

Thus the growth characters are strikingly similar, and the colours of each variety are quite distinct even in the earlier stages of the development of the plants.

A further photograph, Plate 8, illustrates the size-differences of a tall and a dwarf plant from fruits sown on December 21st 1920, and also recorded on June 22nd 1921, or roughly six months from the date of planting. Each plant has the same number of expanded leaves, namely five. Whereas the length of the fifth and largest leaf of the dwarf was 2 feet 9 inches only, that of the tall was 4 feet.

FLOWERING PERIODS AND POLLINATION.

A search through the literature dealing with coconuts reveals little information regarding their flowering periods or pollination. Knuth, in his volume on the "Pollination of Flowers" merely remarks that the coconut is pollinated through the agency of insects. Most books make no mention whatever of the biology of the coconut or its pollination,

Petch, of the Ceylon Department of Agriculture, described the flowers of the tall coconut in detail in popular terms and recorded observations on the flowering periods of a single palm, growing at Peradeniya, which is near the upper limit for coconuts. His observations showed that, under the conditions prevailing at Peradeniya, a period, varying from three and a half to five weeks, was required for the opening of all the male flowers of an inflorescence; that an interval of two to five days then elapsed before the female flowers of the same inflorescence began to open and that the female flowers all opened in a period of from one to seven days according to the numbers of female flowers. According to his observations he naturally concluded that self-pollination was impossible except in the rare occurence of overlapping of inflorescences on the same tree and that coconuts depended on cross-pollination by insects and probably also by the wind. He stated that bees and hornets, which feed greedily on the honey produced by both the male and the female flowers, were the chief visitors to the coconut flowers, and that the ubiquitous ant, though it revelled in the nectar of flowers was unlikely to assist in cross pollination or even to have access to the female flower at all, thanks to the natural protection afforded by its ring of nectar at the recepetive period.

In the warm humid atmosphere of the lowlands of Malaya, coconuts appear to behave differently. The length of duration of the male phase is curtailed, while the duration of the female phase would appear to be longer in both tall and dwarf trees; but the most striking difference is the fact that in Malaya the female phase not only begins, but most frequently ends before, or at the same time, as the male phase, thus rendering self-pollination the rule instead of being an occasional chance occurrence.

PLATE 3.

These notes however are only intended to refer to dwarf coconuts of the 'nyior gading' race, and the following table is of interest:—

Dwarf Coconuts.—Flowering Summary January to March.

Tree Number.	Type	Spathe.	Male phase begins.	Male phase ends.	Female phase begins.	Female phase ends.	Duration of male phase days.	Duration of female phase days.	Number of female flowers.	Female flowers begin to open before end of female phase.	Female flowers being to open after male phase.	All female flowers open before end of male phase.	All female flower open after male phase.	All female flowers open within one day of end of male phase.	All female flowers open within two days of end of male phase.	All female flowers open within three days of end of male phase.
1	R	B	26·1	18 2	10·2	21 2	24	12	11	1	...	...	...	...	...	1
...		C	18 2	12 3	27,2	11 3	13	13	17	1	...	1	...	...	...	...
2	R	D	2,5	24·2	15,2	22 2	23	8	13	1	...	1	...	...	...	...
...		E	28/2	20 3	15 3	20 3	21	6	3	1	...	1	...	...	...	...
4	R	B	26,1	16 2	9,2	16·2	22	8	15	1	...	1	...	...	...	...
5	Y	C	12,1	1,2	1/2	4·2	20	5	3	...	...	...	...	...	...	1
...		D	4/2	25 2	23,2	28 2	22	6	7	1	...	...	...	...	...	1
...		E	3 3	22·3	15/3	20,3	20	6	5	1	...	1	...	...	...	...
5 (a)	Y	C	12 1	30,1	25 1	2 2	19	9	3	1	...	...	...	...	...	1
...		D	2,2	23·2	20 2	24/2	22	5	15	1	...	...	1	...	...	...
...		E	2 3	19·3	12·3	17,3	18	6	22	1	...	1	...	...	...	...
6		B	20/1	9,2	5,2	11,2	21	7	3	1	...	...	...	...	1	...
...		C	19/2	12,3	11 3	15 3	22	5	7	1	...	...	...	...	...	1
6 (a)	Y	B	8/1	27/1	22/1	26 1	20	5	9	1	...	1	...	...	...	...
...		C	30·1	18/2	14/2	18/2	20	5	8	1	...	...	...	...	...	...
...	Y	D	24/2	12 3	7 3	13 3	20	7	10	1	...	...	1	...	...	...
7		D	6 2	22/2	18,2	23 2	19	6	9	1	...	1	1	...	...	...
...		E	24,2	16 3	5 3	11 3	21	7	14	1	...	1	...	...	...	...
8	R	D	26 1	16 2	9 2	15 2	22	7	9	1	...	...	...	...	...	...
...		E	12 2	12 3	2 3	11 3	22	10	11	1	...	..	...	...	...	...
9	R	D	25,1	12 2	2 2	11 2	19	10	25	1	...	1	...	...	...	...
...		E	23 2	14 3	1 3	11 3	20	11	20	1	...	1	...	...	...	...
10	Y	C	27 1	18 2	7 2	18 2	20	12	12	1	...	1	...	..	...	...
...		D	22 2	15,3	28 2	13 3	22	14	17	1	...	1	...	...	...	...
11	R	C	16 1	4 2	30 1	4/2	20	6	11	1	...	1	...	...	...	...
...		D	9/2	1 3	15 2	28 2	21	13	18	1	...	1	...	...	...	...
...		E	10 3	28/3	15 3	21 3	19	7	14	1	...	1	...	...	...	...
12	Y	B	2 1	24 1	26 1	27 1	23	2	2	...	1	1	...	...	...	...
...		C	25 1	15,2	11 2	15 2	22	5	8	1	...	1	...	...	...	...
...		D	26 2	17 3	18·3	21 3	20	4	3	..	1	...	.	...	...	1
13	Y	C	21 1	10,2	7 2	10 2	22	4	7	1	...	1	...	...	...	...
...		D	3 2	23/2	18 2	24 2	21	7	10	1	...	...	...	...	...	1
14	Y	C	10 1	29 1	19 1	25 1	20	7	11	1	...	1	1	...	...	...
...		D	28 1	18 2	5 2	15 2	23	11	13	1	...	1	...	...	...	...
...		E	19 2	8/3	26·2	7 3	18	10	16	1	...	1	...	...	...	...
15	Y	C	7 1	4 2	25 1	2 2	19	6	19	1	...	1	...	...	...	...
...		D	7 2	27 2	18 2	24 2	21	7	14	1	...	1	...	...	...	...
...		E	2 3	18 3	13 3	17 3	17	5	20	1	...	1	...	...	...	...
16	R	D	30·1	13 2	7 2	15 2	15	9	21	1	...	...	...	...	...	...
...		E	73 2	12 3	2 3	11 3	18	10	17	1	...	1	...	...	1	...
17	R	C	7 1	30 1	24 1	30 1	21	7	13	1	...	1	...	...	...	...
...		D	2 2	22 2	11/2	22·2	21	12	16	1	...	1	...	...	...	...
...		E	26·2	17/3	7 3	17 3	20	11	[illegible]	1	...	1	...	...	...	...
		43		AVERAGE			886 21	333 8		40	2	30	4		7	7

The time that elapses between the end of one male phase and the beginning of the succeeding one averages four days.

THE ABOVE TABLE SHOWS.

(1) That the inflorescences on the same tree follow each other after an average interval of four days.

(2) That in two cases only out of forty three, did overlapping of inflorescences occur.

(3) That the average duration of the male phase was 21 days, with a variation of from 15-21 days.

(4) That the average duration of the female phase was 8 days. This average seems independent of the number of female flowers on the inflorescence, but might be reduced over a longer period as the weather was unusually showery, though sunny, during most of the period covered by these records.

(5) That in forty out of the forty three cases, the female phase began before the end of the male phase.

(6) That in forty out of the forty three inflorescences the female phase ended at the time, or earlier than, the male phase, thus making self pollination not only possible but very highly probable.

(7) That the end of the female phase was never more than three days behind the end of the male phase making self-pollination still possible in dry weather, since coconut pollen grains appear to maintain their viability for several days under fairly dry conditions.

(8) That overlapping of inflorescences only occurred twice out of forty three cases.

The trees on which the observations were taken were approximately eight years old and fairly widely planted, but not well cared for as light 'blukar' was beginning to establish itself at the expense of the coconut trees. However, shortly before the observations commenced a space round each tree was cleared and cultivated In support of the facts revealed in the above table, three unopened inflorescences were bagged in muslin bags and it was found that in each case, self-pollination was effected naturally and fruits, which still remained on the trees, were formed.

Again, three other inflorescences were emasculated immediately on opening and it was found that, though the female flowers behaved normally, no pollination took place and no fruits were formed, although male flowers on adjacent trees were in full bloom. In a similar connection, it has been observed that odd isolated coconut trees growing even under bad conditions produce fruit so that self-pollination must have taken place. When coconut flowers are in full bloom, at about 10 a.m., when the dew has dried up and when gentle breezes frequently begin, clouds of pollen can be seen floating away in the sunlight. In a very slight breeze these pollen clouds do not travel far owing to the weight of the pollen but it is highly probable that with the strengthening of the breeze as the day advances the pollen clouds are carried to a considerable distance and thus cross-pollination is effected.

In the earlier part of this paper it was pointed out that ninety six per cent of seedlings of the ivory yellow type of the 'nyior gading' race appears to breed true. In addition to the various facts already mentioned this high percentage also supports the contention that self-pollination is the rule.

SUMMARY.

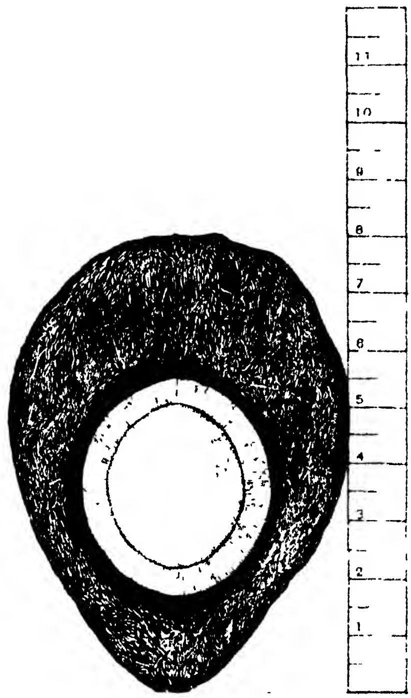
1. The probable origin of the "nyior gading" or ivory-yellow dwarf coconut and two other allied forms, grown in Malaya is discussed.

2. The colour, flower and fruit characters of the dwarf palms are described, as well as the growth and colour differences of the young leaves of the germinating fruits.

3. It is shown that by carefully noting the colour and growth characters of young plants, a fairly accurate separation of the dwarf varieties from semi-tall. and tall forms can be made in the nursery which will enable much purer 'stands' of the type, or types, desired to be established in the field than are usual at the present time.

4. The results of observations on the flowering phases of the palms are given, and it is shown that the flowers are as a rule self-pollinated in the lowlands of Malaya.

PLATE 4.



THE KING COCONUT.

LOCAL LAND TENURE.

BY INCHE MOHAMED NOOR.

THE object of this article is to compare the conditions governing land tenure in Province Wellesley and Penang with those in the Federated Malay States.

It will be interesting first to say something of the lands held in the Straits Settlements under titles issued before the coming into force of the Ordinance of 1886, which ordinance and amendments thereto now govern the conditions of land tenure.

In the first place, the term *Indenture* is used for certain lands held under titles issued by the East India Company. Such lands are Freehold and are rent free. Other lands are held under a *Grant* formerly issued by the Colonial Government on payment of a fixed rent. There are also lands held under *Lease* granted before the coming into force of the 1886 Land Ordinance. These leases are for 99 or 999 years.

Similarly in the Federated Malay States certain lands are still held under agreements made before European administration, as well as other lands held under early laws not now in force. An instance of the former is the *Certificates* which have been issued to persons who have proved their occupation of lands before European administration. These certificates are in perpetuity. An instance of the latter is the *Permit*. Under an old law, not now in force, permits, to occupy in perpetuity, have been issued by the State.

The law at present governing land tenure in the Straits Settlements is the "Crown Lands Ordinance of 1886" and rules since made under it. All lands issued under this existing law are either *Statutory Grants*—a title issued by His Excellency the Governor at a rent subject to revision once every 30 years—or *Lease*, a title carrying special conditions and subject to re-entry if rent is not paid within 30 days after the appointed time.

The law now governing land tenure in the Federated Malay States is the "Land Enactment of 1911" and the land rules under this Enactment. Lands alienated under this enactment are (1) *Grants* which are usually in perpetuity, approved and signed by the Resident; (2) *Leases*, either for mining or agriculture and usually for 21 years and (3) *Entry* in the Mukim Register for lots of 100 acres or less. This E.M.R. is signed by the Collector of Land Revenue of the district. For areas of over ten acres the authority of the Resident must be obtained. A Certificate of Title is issued in cases where Grants of land are transferred or partitioned.

At this stage it may be as well to point out a difference between the "title" in the case of the small holdings in the Straits Settlements and that in the Federated Malay States. In respect to those lands in the S.S., the "title" is the Grant issued and the registry record is the "evidence of title"; whereas in the F.M.S., the "title" is the entry in the Mukim Register, and the Extract from the Mukin Register issued to the owner, is only the "evidence of title."

Application for Crown Land in Province Wellesley and Penang, whether exceeding ten acres in area or below ten, should be made in writing addressed to the District Officer of the district in which the land applied for is situate. The same procedure is adopted in the F.M.S. except that the application by natives for land not exceeding ten acres in area can be made orally, either to the Collector of Land Revenue or to the Penghulu of the Mukim.

The Collector of Land Revenue for the Island of Penang, the Senior District Officer for Province Wellesley and the District Officer for Dindings have in their respective districts authority to approve all applications for land the area of which does not exceed 5 acres; whilst the Collectors of Land Revenue in the F.M.S. can approve applications up to ten acres. In all other cases, the approval of the Residents of the State in the F. M. S. or of the Resident Councillor in Province Wellesley and Penang must be obtained.

Lands in the F.M.S. held under E.M.R. are subject to any of the following conditions endorsed by the Collector on the Title:—

(a) That within the first year from the date of his receiving authority to occupy the land, the applicant shall plant up one-half of the land and before completion of the third year plant up the remainder of the land, with such number of trees of economic value and of such kinds as may be determined by the Collector at the time of approving the application and shall thereafter maintain the land and the trees to the satisfaction of the Collector;

(b) That the Collector, at the time of approving the application, may determine that no specified products may be cultivated on the land.

(c) That the Collector may determine that only specified products may be cultivated on the land.

In the Straits Settlements no one is allowed to plant tapioca or pine-apples or other crops which are exhaustive to the soil, except on the condition that rubber or coconut or other approved trees shall also be planted on the land; but in all cases in which land is to be granted on special conditions as to planting or cultivation, such conditions, agreed to by the applicant, shall be endorsed on the Grant.

Premium and Rent in the S.S.—Regarding premium of land, the officer authorised to approve the land applied for shall decide whether there shall be reserved a premium or an annual payment in lieu thereof, but in the absence of special circumstances the following rules are to be observed :—

(a) In lieu of premium, an annual payment in addition to quit-rent may be accepted in the case of agricultural land which is likely to be occupied permanently.

(b) The demand of premium shall be made on all agricultural or other lands liable to be abandoned through exhaustion of the soil by the crop planted or from any other cause.

Any portion of the payment in lieu of the premium may at any time be reduced by payment of the amount of premium which it represents.

When lands are alienated for auction, the price paid by the successful bidder shall be the premium.

As regards quit-rent, the minimum is $1.50 per acre on agricultural land held under Statutory Grant, subject to revision every thirty years.

Premium and Rent in the F.M.S.—The minimum premium on agricultural lands having road frontage and exceeding ten acres in area is $3 per acre and on those having no road frontage is $2 per acre. In Pahang no premium is payable on agricultural lands that exceed the above area. Agricultural lands not exceeding ten acres in area are divided into three classes. On first class lands the premium is fixed by the Resident when such lands are not alienated for auction ; but when such lands are alienated for auction, the premium thereon is the price paid by the successful bidder at the auction. No premium is charged on lands of the second and third classes. Lalang land may be alienated without premium.

The annual rent in respect of lands exceeding ten acres in area and not subject to a cultivation condition is as follows :—

(a) For first class lands.—		$1 per acre per annum for the first six years and thereafter $4 per acre per annum.
In Pahang	do.	50 cents per acre per annum for the first six years. $2 per acre per annum from the 7th to the 10th year. $4 per acre per annum after the 10th year.
(b) For second class lands.—		$1 per acre per annum for the first six years. Thereafter $3 per acre per annum.
In Pahang	do.	$3 per annum after the 10th year.

The following rent is charged on lands not exceeding ten acres in area :—

(*a*) For first class lands.—	$1.20 to $3.20	per acre per annum
In Pahang do.	$1.00 to $3.20	do
(*b*) For second class lands. —	.80 cents per acre per annum	
(*c*) For third class lands. —	.60 cents per acre per annum	
(*d*) For lalang lands. —	$1 per 100 acres or part thereof for 7 years and thereafter **$1** per acre.	

In Province Wellesley and Penang the usual rate of the rebate of rent is two-thirds on land cultivated with coconut or with rubber and in the F.M.S. the rebate of rent on land cultivated with coconuts is such as to reduce the rent to $2 per acre. On land cultivated with any other approved agricultural product the rate of rebate is such as to reduce the rent to $1 per acre. Rebate allowed in Province Wellesley and Penang will not be for more than six years and that in the F.M.S. will continue only so long as the land is kept under bona fide cultivation.

The sub-letting of land in Province Wellesley and Penang and in the Federated Malay States is fairly common. Land is leased out to another person by mutual agreement made in a lawyer's office. The terms and the period of the lease are to be stated therein together with the amount. The Agreement is duly stamped in the Stamp Office.

The fee for the preparation and registration of a Grant or Lease in Province Wellesley and Penang is $5 and the fee for the preparation of a Grant in the F.M.S. is $2.

Survey charges in the Straits Settlements are as follows :

For lots not exceeding 2 acres	$5.00 per lot
For lots exceeding 2 acres and not exceeding 5	10.00 ,,
For lots exceeding 5 acres and not exceeding 10	20.00 ,,
For lots exceeding 40 acres and not exceeding 50	60.00 ,,
For lots exceeding 50 acres and not exceeding 100 — $1.20 for every acre or part thereof.	
For lots exceeding 100 acres and not exceeding 500 acres — $120.00 for the first 100 acres, and 90 cents an acre for every additional acre or part thereof.	

In the F.M.S. the survey charges on agricultural lands not to be held by Entry in the Mukim Register are as follows :—

(*a*)	5 acres and under	$15.00
	for each additional acre up to 10 acres ...	2.00
	10 acres	25.00
	for each additional acre up to 25 acres ...	1.50
	50 acres	85.00
	100 acres	135.00
	500 acres	475.00

(*b*) on lands to be held by E.M.R. :—

3 acres and under.	...	...	...		$3.00
for each additional acre up to 10 acres				...	1.00
10 acres	...	...	...	...	10.00
25 acres	...	...	...	...	21.25
50 acres	...	...	...	...	16.25

CHEMICAL NOTES.

BY B. J. EATON.

CASTOR OIL CAKE.

A number of samples of locally manufactured castor oil and of castor oil cake from seed harvested on a local estate have been examined.

Although the oil content of the cake is rather high, which will retard somewhat the decomposition of such cake in the soil, it is considered that, under tropical conditions, the cake should be suitable as a fertiliser. Its use has been recommended on one or two coconut estates, since the price is considerably lower than imported cake from India or Ceylon. Information kindly supplied by Mr. Kelway Bamber, Government Agricultural Chemist, Ceylon, shows that cake containing even a higher percentage of oil is used as a fertiliser in Ceylon.

CITRONELLA OIL.

A sample of Citronella oil distilled at the Department was forwarded to the Malay States Information Agency for sale and realised 2/6 per lb, which was the top market price of this oil at the time. The quality was considered to be equal to the best Burmah oil, which has the same value as the Java oil.

PINK SPOT ON TREE SCRAP.

Enquiries have been received in connection with the occurrence of pink spot on tree scrap. This spotting, which sometimes occurs on the scrap on the tree on the day after tapping and sometimes develops on such scrap after being brought to the factory, is considered to be caused by *Bacillus prodigiosus*. The spot will not affect other rubber except by actual contact with wet rubber. If the tree scrap is badly infected it may be advisable to sort out the affected scrap and to crepe this separately or with a lower grade, such as bark scrap or earth scrap, since the pink discolouration may persist in the finished crepe and will lower its market value. As far as is known this spot does not affect the real quality of the rubber.

PINK SPOT ON BLANKET CREPE.

For several months past, the blanket crepe prepared from native unsmoked sheet in several of the large factories in Singapore has been badly affected with pink spot.

In some cases the discolouration has been found by the writer on the original sheets, while in others it has developed in the thick crepe during drying.

The drying rooms in these Singapore factories are however very poor and ill-ventilated and the humidity must be extremely high, especially in the damp atmosphere in Singapore.

In such cases the only remedy is to prepare a thin crepe, which should be hung till completely dried and then converted to blanket crepe by re-milling. The thin dried crepe when converted to blanket crepe will only absorb a small amount of moisture, chiefly on the surface, which is more rapidly evaporated than the moisture in the interior of wet blanket crepe.

The soaking of the thick crepe, if prepared direct from the sheets, in a dilute solution of formalin should also eliminate or reduce the tendency of such spot disease, since pink spot and other coloured spots on rubber are produced by different organisms, which can only develop in the presence of moisture and air.

INVENTIONS.

The Peachey Process :—Although this invention is now more than two years old, interest in eastern tropical rubber producing countries has been aroused by the fact that a company has been started to work the process in Ceylon and Malaya.

The process is based on the discovery that when the two gases sulphur dioxide and hydrogen sulphide are allowed to interact, nascent sulphur is produced which is extremely reactive and vulcanises rubber, placed in a chamber in which the reaction takes place, at low temperatures.

The rubber is subjected to the action of the two gases successively so that the sulphur is liberated in the rubber.

Since raw rubber is not a good absorbent of gases it would appear that only thin layers or sheets of rubber can be treated successfully. If thick sheets are used, only a surface vulcanisation will be effected It has been found however that, by dissolving rubber in a solvent and then treating the rubber solution with the two gases, vulcanisation is effected in the solution, or the rubber can be dissolved in one portion of the solution and the gases in another portion and the two solutions mixed to effect the same result.

When the final solution is evaporated, the residual rubber is found to be vulcanised. This two-solution process therefore enables thick vulcanised articles to be built up from thin sheets.

The chief advantages of the process are : –

(1) The elimination of steam and heat required n the present hot process of vulcanisation.

(2) Its rapidity compared with the hot process of vulcanisation.

(3) The regulation of the amount of sulphur necessary for vulcanisation, so that no excess is left in the manufactured articles to cause "blooming."

(4) The gases are said to be cheap and easily obtained or produced.

(5) Colouring matters, especially organic dyes and other organic filling materials which are affected by the hot process of vulcanisation, can be introduced.

The process should have a number of new applications for the manufacture of articles in which rubber may be partly or wholly substituted in place of other materials. A few such applications are the manufacture of floor, wall and upholstery coverings, boot and shoe manufacture, bags and other leather articles, proofed coloured fabrics as water-proof garments, belting, packing material, toys, boxes and roofing and insulating materials.

Schidrowitz Process: —In this process, latex in an alkaline condition (to inhibit coagulation) is vulcanised direct by the addition of a vulcanising agent (sulphur or an alkaline polysulphide) with or without the use of accelerators, and the application of a suitable temperature and pressure.

The caoutchouc or rubber in the latex is stated to be vulcanised and the vulcanised rubber remains in colloidal suspension, little or no coagulation taking place. The rubber is separated from the vulcanised latex by evaporation or by the addition of a suitable coagulant. The vulcanised rubber so produced may be washed, milled or sheeted and subsequently dried and manufactured into various articles. The vulcanised latex may also be evaporated on fabrics, producing a proofed material. Colouring and other filling materials can be added to the latex to produce a number of different articles. The applications of this process would also appear to be extensive and somewhat similar to those of the Peachey process.

It is interesting to note that Devon Estates Ltd., Malacca, has acquired rights for this process.

Kaye's Process:—The invention by Kaye has a definite object viz. the incorporation of latex with paper pulp, for the production of a stronger and more satisfactory paper making material or for the manufacture of cardboards etc. This process also indicates a new use to which rubber can be put.

Laub Process: -The Laub process, invented by Mr. Laub of Johore, consists in the addition of sulphur, as a vulcanising agent, and other fillers direct to latex. The mixture is coagulated and the thick mass of rubber and fillers can be moulded while still wet and subsequently dried and vulcanised by heat..

This part of the process however would appear to be similar to proposals brought forward by Bamber and others some twelve or more years ago.

One novel aspect of the Laub Process however is the discovery that when fine powders are added in sufficient quantity to latex, the latex coagulates without the addition of other coagulants. Basic substances, in the form of fine powder, such as zinc, magnesium, lead or calcium oxides and the carbonates can be used.

The most important point however, arising out of the Peachey and Schidrowitz processes in particular, and in connection with the use of certain accelerators, is the recent hypothesis put forwards by Bedford and Sebrell in America, that the reactive (nascent) sulphur, produced in the Peachey process and by the use of polysulphides and certain accelerators, is tri-thio-ozone, which these investigators claim to have isolated. These investigations may have far reaching effects in connection with the vulcanisation of rubber.

The writer is of opinion that new processes of this nature are likely to have more effect on the consumption of raw rubber than most of the proposals made for the utilisation of raw unvulcanised rubber in the manufacture of various rubber goods. In such processes also, almost pure rubber can be used, if required, in the manufacture of certain articles, since these need only contain, apart from the rubber, the small amount of sulphur essential for vulcanisation and would not develop the defects usually associated with the use of raw unvulcanised rubber. Articles containing such high proportions of rubber require the test of time to ascertain their lasting qualities.

PROGRESS REPORT ON THE EXPERIMENTAL PLANTATION, SERDANG.

BY B. BUNTING.

THE opening up of the Agricultural Reserve at Serdang with a view to establishing a Large Scale Experimental Plantation, for crops other than Rubber and Coconuts, in the State of Selangor was commenced on the 15th October, 1920. The present area of the Reserve is approximately 1000 acres. The following report shows the progress made up to September, 1921.

FELLING AND CLEARING JUNGLE.

Altogether an area of about 650 acres has been felled and burnt off. Of this area 248 acres have been stumped and clean cleared of all timber whilst clean clearing is now in progress on the new 200 acre block recently transferred from Mining Reserve to Agricultural Reserve. At the present rate of progress it is expected that by the end of 1921 an area of approximately 450 acres of land will be clean cleared and free from all timber and bertam stumps ready for planting, whereas the proposed planting programme only requires 440 acres of land up to the end of 1922.

It might be mentioned that immediately the areas are clean cleared they are planted up with a leguminous cover crop, principally *Centrosema plumieri*, which will be allowed to remain until the land is required for planting purposes.

PROPOSED PLANTING PROGRAMME.

The proposed planting programme will be found at the end of this report and reference to it will show the areas of each crop which it is proposed to plant each year up to the end of 1923.

This programme is provisional and areas under any particular crop may be increased or reduced according to circumstances. Any new crops likely to be of commercial importance will be added to the list from time to time and to make this as representative as possible a close watch is being kept on all publications from other tropical countries with a view to procuring such planting material as may be required.

An area of approximately 10 acres of land was specially reserved for nurseries and this has been divided up into three blocks which contain altogether 365 nursery beds, some of which are shaded and the balance left open for plants which do not require shade. The area is situated near a good water supply and is securely fenced in with barbed wire.

The nurseries are well-stocked with planting material most of which will be ready for planting out in the field during the next three months.

Planting Material.

Although it has not yet been possible to plant out the various crops in their permanent quarters in the open most of the planting material is ready in the nurseries and it is only a question of selecting the areas on which the different crops are to be planted.

As soon as the new area of 200 acres has been clean cleared the whole of the land will be carefully measured out into blocks of varying acreages and classified according to the soil conditions, etc., before being alloted to any particular crop.

The proposed programme contains a comprehensive list of crops to be given a trial and every effort has been made to collect planting material as the following information will show :—

(1) Planting Material in Nurseries at Serdang.

Sugar Cane.—Stock of 14 of the best varieties of cane grown in Java, now well-established.

Sugar Palm.—About 4,000 seeds planted, germination slow, but many seedlings now appearing.

Coffee.—A large supply of seedlings of 5 high-yielding varieties obtained from Java in 1915. Sufficient to plant up at least 10 acres.

African Oil Palm.—Four lots, comprising over 10,000 seeds, from Experimental Plantation, Kuala Lumpur, in addition to 1230 seeds of a hard-shelled variety from Nigeria, germination fair, but incomplete.

Illipe Nut.—2,000 seeds newly planted in nurseries.

Castor Oil.—A small supply of seed of an early-cropping variety was received from Rhodesia and sufficient seed has been harvested to plant up one acre in the open. One acre of large-seeded (Kedah) variety and four acres of small-seeded local variety sown in the open.

Candle Nut.—400 seeds have been planted in nurseries,

Citronella Grass.—Over 10,000 bundles planted on roadsides—will be sufficient to provide stock later.

Lemon Grass.—100 bundles planted in nursery beds.

Patchouli.—A fair number of cuttings of the ordinary variety has been sent out from Kuala Lumpur and established in nurseries.

Vetiver Oil Grass.—About 40 small clumps, obtained from Port Dickson, planted in nurseries.

Sisal Hemp.—25,000 bulbils now ready for planting.

Mauritius Hemp.—16,500 bulbils ready for planting out.

Kapok.—About 10,000 seeds planted in nurseries. Germination very good and many plants now ready for planting out in field.

Cotton.—Selected seed of varieties of Sea Island cotton received from the West Indies, grown in the open. Growth shown was satisfactory and pure seed has been saved for further experiments. Samples of the cotton are being sent to England for examination.

Roselle Fibre.—About 7,000 seeds planted in nurseries have shown good growth and are being allowed to flower for seed production

Roselle (Red type).—Two dozen cuttings have been planted in nurseries.

Bowstring Hemp.—500 plants have been planted up in nurseries.

Bromelia Fibre.—A few fibre plants of a species of Bromelia have been planted in nursery beds in the shade.

Manila Hemp. 100 suckers have been planted out in the open and are doing well.

Sunn Hemp. One bed of plants in nurseries.

Bimlipatum Jute. A small supply of seed, received from Kuala Kangsar, has been planted in nurseries.

Rhamie. 100 rooted cuttings planted in nursery beds.

Cinnamon. Sufficient seedlings to plant up 10 acres established in nursery beds. They are somewhat small as yet, but doing well.

Vanilla. 3 boxes of rooted-cuttings have been planted in nurseries

Cloves. 10 lbs. of seed recently planted in nursery beds.

Ipecacuanha. 50 young plants are established in nurseries.

Coca (Cocaine). A few seedlings are growing in nurseries, whilst 1 lb of fresh seed has been sown recently.

Croton Oil. A large number of seedlings is now ready for planting out.

Annatto. A large supply of seedlings in nursery ready for planting.

Tuba Root. A few cuttings have been established in nurseries.

Limes. 2,000 lime fruits were obtained from the Jong Fruit Growing Syndicate, Teluk Anson, and these have produced sufficient seedlings to plant 20 acres. Germination commenced within three weeks of sowing the fresh seed and the plants are growing well.

Betel Nut. 1,000 seeds planted in nurseries.

Guinea Grass. 2,000 small clumps have been established.

In addition to the above over 1,000 lbs of *Centrosema plumieri* seed have been planted in the open as a cover crop. A number of shade and ornamental trees has also been planted on the roadsides.

(2) PLANTING MATERIAL AT KUALA LUMPUR.

Patchouli, Rooted cuttings of *Pogostemon cablin,* the true patchouli, have been received from the Bureau of Agriculture, Philippine Islands.

Pineapples. Stocks of both Mauritius and Kew pines are ready for planting when required.

Manila Hemp. A further 300 strong plants are being grown ready for Serdang.

Bromelia Fibre. Four plants of a Bromelia species are still in stock.

Bowstring Hemp. Further stocks are ready for planting out at Serdang.

Lemon Grass. Further stocks are available when required.

Tuba Root. Further stocks are being propagated.

Sugar Cane. A large collection of local canes, comprising 94 lots, obtained from the different districts throughout the Peninsula, was made in October. 1920, and the canes are now ready for harvesting. After being sorted and classified they will be sent out to Serdang and should provide planting material for about 5 acres.

Cover Plants. Stock plants of the majority of cover crops and green manures are available when required.

(3) SEEDS AT KUALA LUMPUR.

Roselle Fibre. Seed of the Roselle fibre plant has now been received from the Bureau of Agriculture, Philippine Islands, and from the Superintendent, Government Plantations, Kuala Kangsar, and will shortly be sent out for planting at Serdang, where land is now being prepared.

Caravonica Cotton. A small supply of seed has just been received from Kuala Pilah.

Pepper. About 10 lbs of seed received from Penang.

Nutmegs. 1,000 seeds received from Penang, sufficient to plant 10 acres.

Tobacco. A small quantity of tobacco seed received from Ceylon.

Miscellaneous Seeds. The following seeds have been received from the United States Department of Agriculture, Washington.

Soya Bean, Biloxi	Early Buff Cowpea
Bush Velvet Bean	Victor Cowpea
Georgia Velvet Bean	Groit Cowpea
Otootan Soya Bean	Mammoth Blackeye Cowpea
Brabham Cowpea	
Honey Sorgo	Orange Sorgo
Sumac Sorgo	Gooseneck Sorgo
Napier Grass	Red Amber Sorgo
Carpet Grass	Merker Grass
Dallis Grass	Rhodes Grass
Sudan Grass	Bahia Grass
Beggarweed.	Alabama Grass

Labour

At the present time there is a plentiful supply of Chinese labour available in the Serdang district at the following rates of pay—adult males 55 cts, adult females 50 cts, and minors 25 cts per day, which is remarkably low for this class of labour. So far the work has been carried out by casual labour and it will be advisable later to have a number of permanent labourers resident on the plantation to carry out regular work.

Buildings.

A temporary hostel is being erected on the plantation and will shortly be completed, when it will be possible to give more time to details in connection with the planting out of crops which are now ready to leave the nurseries.

Water Supply.

There appears to be a plentiful supply of good water available on the plantation and the Director of Public Works has been asked to draw up a suitable scheme for supplying the future needs of the plantation and submit an estimate as to its probable cost.

Roads.

The plantation is situated about two miles from the main road from Sungei Besi to Kajang and is only approachable by a rough cart-track, parts of which are inundated with water during wet weather. The absence of a permanent access road to the plantation will very soon prove a serious drawback to its development and it is hoped that conditions will allow of the construction of such a road being commenced as early as possible and completed early next year. A number

of buildings is to be erected on the plantation during the coming year and the construction of a permanent road will greatly facilitate the transportation of building material to the sites which have been selected.

GENERAL.

There is no doubt that the present area of flat and undulating land, suitable for the cultivation of temporary crops, will prove far too small for future requirements and steps are being taken to obtain a further area of 350 acres of State Land in the Mining Reserve adjoining the plantation.

The addition of the above area will make a considerable difference to the value of the plantation from an experimental point of view and it will be possible either to increase the areas under each crop or to increase the number of crops under experiment, whichever may prove necessary. Further, it will also be possible to reserve a block of at least 100 acres for an economic garden, where every plant of economic importance can be represented by plots varying from 1/40 to 1/2 an acre, according to the size or nature of the plant to be included in the garden. An economic garden of this description would not only be of considerable value from a botanical standpoint in connection with plant-breeding, but would be of considerable interest to the general planting public in illustrating the different types of economic plants, together with their general habit of growth. Further information on any particular crop grown on a large scale could, in a large number of cases, be obtained in the field.

In conclusion it may be stated that excellent progress has been made so far and, with one or two exceptions, sufficient planting material has been procured to carry out the programme which was previously arranged.

PROPOSED PLANTING PROGRAMME FOR SERDANG.

Crop.	1921	1922	1923	Total.	Remarks.
FOOD CROPS.	acres.	acres.	acres.	acres.	
Tapioca	2	—	—	2	
Sugar-Cane	10	10	30	50	
Bananas	2	8	—	10	
Groundnuts	1	10	—	11	
Sago Palm	5	5	—	10	
Sugar Palm	10	—	—	10	
Coffee	10	5	—	15	
Cocoa	—	1	—	1	
Tea	—	15	—	15	
Pineapples	1	4	—	5	
Soya Bean	2	—	—	2	
OILS AND FATS.					
African Oil Palm	—	50	50	100	
Castor oil	20	—	-	20	
Candle nut	—	10	10	20	
Gingelly	10	—	—	10	
Tenkawang	5	—	—	5	
Citronella grass	10	—	—	10	
Lemon Grass	10	—	—	10	
Patchouli	1	4	5	10	
Bay Trees	-	1	—	1	*Avenue or headges*
FIBRES.					
Sisal Hemp	25	—	—	25	
Mauritius Hemp	25	—	—	25	
Manila Hemp	½	2	8	10½	
Sunn Hemp	5	—	—	5	
Rhamie	1	—	—	1	
Bowstring Hemp	1	—	—	1	
Cotton	1	5	—	6	
Kapok	—	25	—	25	
Roselle	10	—	—	10	
SPICES.					
Nutmeg	—	10	—	10	
Cinnamon	10	—	—	10	
Cloves	—	10	—	10	
Pepper	—	—	10	10	
Vanilla	—½	—	1	1½	
Carried Forward.	178	175	114	467	

PROPOSED PLANTING PROGRAMME FOR SERDANG (CONT.)

Crop.	1921	1922	1923	Total.	Remarks.
	acres.	acres.	acres.	acres.	
Brought Forward	178	175	114	467	
DRUGS.					
Ipecacuanha	2	—	2	4	*Planted in*
Coca	1	—	4	5	*Jungle strips.*
Croton oil	—	5	—	5	
Camphor	—	—	—	—	*To be consider-*
Kola nut	5	—	5		*ed later.*
DYESTUFFS.					
Indigo	10	—	—	10	
Annatto	5	—	—	5	
Gambier	1	—	50	51	
MISCELLANEOUS PRODUCTS.					
Tobacco	1	—	—	1	
Tuba Root	—	5	5	10	
Brazil Nut	—	10	—	10	
Limes	20	20	10	50	
FODDER PLANTS.					
Guinea Grass	2	—	—	2	
Total.	225	215	185	625	

NOTES: This programme is a provisional one and therefore subject to alteration from time to time in order to meet any requirements which may arise later.

CENTROSEMA PLUMIERI.

NOTE ON THE OIL CONTENT OF THE SEEDS.

By C. D. V. Georgi.

ENQUIRIES have been received regarding the possibility of utilising for oil extraction the surplus amounts of this seed, which is being planted to such a large extent on estates as a cover crop. Although this plant is a legume and its seed is therefore unlikely to have a high oil content, the complete analysis was undertaken in order to obtain exact data.

The results were as follows:—

Number of seeds per oz.	153
equivalent to per lb.	2448
Proportion of kernel	74 .7 per cent.
,, of husks	25 .3 ,,
	100 .00

	Whole Seed. per cent.	Husk. per cent.	Kernel. per cent.
Moisture	14.77 ...	13.47 ...	15.67
Ash	2.24 ...	2.18 ...	2.35
Organic and Volatile matter (by difference)	82.99 ...	84.35 ...	81.98
	100.00	100.00	100.00
Containing			
Nitrogen	2.84 ...	0.74 ...	3.54
Oil	1.25 ...	— ...	1.67

From these results it will be seen that, as expected, the oil content is very low and that its extraction as a commercial propositoin is not to be considered.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of January, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb	Vapour Tension	Dew Point.	Humidity.			
Kelantan, Kota Bahru ...	...	146.76	79.5	87.70	72.24	14.96	75.5	.804	72.7	79	...	5.80	1.32
Pahang, Kuala Lipis	...	...	79.52	86.67	73.35	13.35	75.19	...	—	...	...	8.52	2.27
Johore, Johore Bahru ...	...	...	...	87.24	73.22	...	...	...	—	...	...	4.77	1.20
Singapore, Kandang Kerbau ...	1015.0	103.5	81.33	84.7	66.8	...	78.1	...	—		Calm.	6.03	1.61
Malacca, Durian Daun ...	1017.7	133.00	81.00	88.00	73.00	15.00	77.00	.890	—	81.00	N.	2.95	.92
Negri Sembilan, Seremban ...	...	141.9	79.9	89.6	72.9	16.7	75.6	.800	72.7	78.8	N. W.	8.59	1.25
„ Kuala Pilah ...	...	155.1	80.00	87.2	71.1	16.1	76.5	.844	75.4	82.8	...	10.16	3.60
„ Port Dickson	...	152.6	82.6	87.6	73.6	13.7	77.2	.845	74.4	78.6	...	4.64	1.10
Selangor, Kuala Lumpur ...	...	...	82.3	90.6	70.4	20.2	76.8	.816	73.2	74.	S. E.	8.61	2.36
„ Klang	...	...	80.1	84.3	74.5	9.8	76.3	...	...	...	—	8.16	1.47
„ Kuala Selangor ...	...	...	...	90.	69.9	20.1	...	...	...	...	—	5.58	2.78
„ Rawang	...	...	...	89.6	72.6	17.0	...	...	...	...	—	7.70	1.48
Perak, Telok Anson	...	...	80.93	92.	70.	22.	76.62	.860	...	82.	—	5.62	1.65
„ Ipoh	...	...	80.83	93.	70.	23.	75.14	.829	73.54	80.	—	11.41	1.61
„ Taiping	...	...	82.05	92.	70.	22.	78.65	.924		87.	—	23.89	2.48
„ The Cottage	...	...	...	...	...	...	...	—	...	...	—	27.57	5.98
„ Parit Buntar	...	...	82.22	92.	71.	21.	77.47	.878	70.6	83.	—	4.56	.90
Penang, George Town... ...	1008.5	160.	80.2	94.	70.	24.	77.8	.913		88.9	N. W.	5.47	1.69
Kedah, Alor Star	...	...	...	...	...	...	...	—	...	...	—	3.49	1.16
Perlis, Kangar	...	...	...	88.90	71.74	17.16	...	...	...	...	—	3.14	1.80

THE

Malayan Agricultural Journal.

Vol. X. FEBRUARY, 1922. No. 2.

EDITORIAL NOTES.

ADVISORY COMMITTEE 1922.

THE following gentlemen will constitute the Advisory Committee, Department of Agriculture, for the year 1922.

The Secretary for Agriculture (Chairman), The Hon. Mr. R. C. M. Kindersley, Messrs. W. S. Cookson, W. R. Shelton-Agar, S. Wierman, M. J. Kennaway and R. Napier Hendrie.

PROPAGANDA.

Illustrated Posters on the Black Beetle and Red Stripe Weevil of coconuts, and on the Padi Borer (*Schnoebius bipunctifer*) "Ulat Layar" or "Ulat Gading" printed in Malay and in Tamil have been distributed throughout Malaya: these notices contain brief life histories of the pests, together with simple instructions as to their control.

Several Cinema Films were prepared in connection with the Malaya-Borneo Exhibition; certain of these deal with pests of rubber and their treatment, others with cultivation of crops. It is proposed to utilise these after the Exhibition to illustrate lectures in various parts of the country and for this purpose the Department of Agriculture hopes at a later date to obtain a portable cinema lantern.

MARKETS.

Numerous enquiries from abroad have been received of late as to whether Malaya is in a position to export kapok. This demonstrates a world-wide demand for this commodity. A recent enquiry from a firm in Singapore states that there are enquiries for kapok from New Zealand. If interested readers will correspond with the Department, the latter will be pleased to place them in touch with the firm in question. Please quote No. 59 in D.A. 525/22 in this connection.

An enquiry has been received from a firm in London who would like a good-sized sample of Roselle Fibre, and who enquire what quantity of the Fibre would be available in this country. The Department of Agriculture has arranged to send the sample, but

growers of the Fibre who wish to communicate with the firm are asked to write to the Secretary for Agriculture quoting as a reference D. A. 1202/1922.

COCONUT SPIKE MOTH.

It is particularly requested that managers of Estates who notice damaged coconut spikes, and who are not acquainted with the cause of the injury, will forward these for report (labelled Entomological Specimens), to the Secretary for Agriculture.

SOME PLANT OILS OF MALAYA, THEIR EXTRACTION AND USES*

By C.D.V. Georgi.

INTRODUCTION.

THE objects of this article are to bring to notice some of the more important oils which can be extracted from trees and plants growing in this country, to describe and illustrate the various methods employed, and finally to state their commercial uses.

Malaya, like all tropical countries, is particularly rich in oil-bearing plants which hitherto have been exploited only to a small extent, but it is thought that a greater number will receive attention in the future.

The term "Plant Oils" includes two different types of oils, namely fixed oils or fats, and volatile or essential oils. The fixed oils or fats are those which cannot be volatilised without decomposition, while the opposite applies to the volatile or essential oils.

This difference can also be illustrated by a simple experiment. A drop of a fixed oil, such as castor oil, produces on a piece of paper a translucent spot which, even if warmed, does not disappear on exposure to air, (it would decompose if heated too much); a drop of essential oil, such as citronella or lemon oil, however, will give a similar translucent spot, but this will disappear on exposure to air, at the same time a strong and characteristic odour will be emitted, which serves as a further distinction between fixed and volatile oils, fixed oils in the pure state being odourless.

As, moreover, the methods of extraction of these oils, their composition and the uses to which they are put are dissimilar they will be considered separately.

FIXED OILS OR FATS.

Description and Classification. In plants, these oils and fats are found in considerable quantities in the seed, where, together with starch and proteins, they serve as food which would be required were the seed allowed to develop.

A fixed oil or fat cannot be regarded as a definite chemical compound but as a mixture of such, the proportion of the constituents varying according to the conditions under which the plant is grown, e.g. the soil, climate, altitude and other factors; generally however,

*Note:—This article is based on a lecture and demonstration given by the writer at the 3rd Annual Conference of Malay Officers of the Agricultural Department September 1921.

such an oil or fat consists of a mixture of glycerides of fatty acids with which a small amount of free fatty acids may also be associated.

The term "glyceride of fatty acid" indicates the chemical compound resulting from the action of glycerol on a fatty acid, in other words, a glycerol salt. To take a simple example, in the same way that sodium chloride (salt) may be regarded as one of the products of the action of caustic soda (base) on hydrochloric acid (acid), so a fixed oil or fat (salt) may be looked upon as one of the products of the action of glycerol (base) on a fatty acid (acid), or written as a chemical equation:—

Caustic Soda + Hydrochloric Acid = Sodium Chloride (Common Salt) + Water.

Glycerol + Fatty Acid = Glyceride of Fatty Acid (Oil or Fat) + Water.

The question of the free fatty acid is very important, since upon the amount present in the oil or fat depends to a large extent its possible uses and consequently its value. The reduction of this acidity to a minimum is one of the chief points to be considered in the extraction.

No sharp distinction can be made between oils and fats, for an oil when cooled sufficiently becomes a fat and a fat when melted becomes an oil, it is merely a question of temperature. A general rule in Europe is to apply the term "oil" to those which are fluid, and the term "fat" to those which are solid at a temperature of 20° C, but this does not hold good in Malaya where the normal temperature is above this figure.

In adopting the modern system of distinction between fats and oils, it is customary to sub-divide the oils further according to whether they are drying, semi-drying, or non-drying and to treat fats as a class by themselves.

It is well known that, when certain oils are exposed to the air, the surface of the oil films over (solidifies) or in other words the oil is said to "dry". This drying effect is due to the absorption of oxygen from the air, because no such change will take place if the oil be kept in a receptacle from which air is excluded or which is filled with an inert gas, such as nitrogen. Some oils, such as linseed oil, dry at a normal temperature, while others, such as candle nut, dry only after heating.

To determine experimentally the amount of oxygen which a given amount of oil could absorb would be very difficult, but as it has been found that the quantity of iodine which an oil can absorb under standard conditions stands in very close relationship to the quantity of oxygen which it is capable of absorbing, a general classification based on what are termed "Iodine Values" has been adopted and oils are called drying, semi-drying or non-drying according to their high or low "Iodine Values".

This property of drying also determines the use to which the oil can be put, as oils which dry well are largely used in the manufacture of paints and varnishes, the film produced as a result of the "drying" forming the protective coating on the material painted.

Preliminary Treatment and Extraction.—Although there are only two methods employed for the extraction of oil from seeds and fruits, namely by expression or by using a chemical solvent, it will be seen from the above list that the preliminary treatment must vary with the particular type of seed or fruit and that machinery must be chosen accordingly. Thus a soft fruit such as African oil palm, which yields two different oils, namely palm oil and palm kernel oil, requires very different treatment from rubber seed or castor seed. Further in order to obtain the best quality oil, care must be taken to ensure that the fruits or seeds are gathered when ripe and stored under proper conditions or treated without delay according to circumstances. Fruits such as the African oil palm must to expressed as soon as they are ripe, otherwise if the fruit is allowed to become over-ripe and moist the enzymes or ferments in the fruit act on the oil, producing large quantities of fatty acids far in excess of the very small amounts present in the ripe fruit. Similarly, seeds such as those of rubber or castor must be stored dry, otherwise they will tend to heat, with the result that the fat splitting ferments will act on the oil, producing, as in the case of the palm oil, large quantities of fatty acids, with a consequent deterioration in the value of the oil.

When extracting the oil by the method of expression the seeds or nuts are first subjected to a process known as decortication, if the removal of husks or shells is necessary. The oil cells in the seeds are then ruptured by crushing the material to a coarse meal by passing it through a series of rollers or millstones. The meal is then heated to about 50° C and pressed in some kind of press, hydraulic generally, as a result of which the greater part of the oil is squeezed out and a cake containing the remainder is left in the press.

"Expellers," machines working on a screw principle, which combine the two operations of crushing and expression to a certain extent, may also be employed.

Occasionally, the crushed meal must be expressed cold as, when pressed hot, some deleterious substance may pass into the oil which may either render it unfit for the proposed use or decrease its commercial value. An instance of this is the extraction of medicinal castor oil which is always "cold drawn"; if pressed hot, the poisonous principle, ricine, will pass into the oil, thereby rendering it useless for medicinal purposes.

Extraction in the cold does not yield as much oil as when carried out in the hot, for in the cold the oil is more viscous and flows less readily, so that a considerably larger quantity remains in the cake; hence it is customary after an expression in the cold to heat the meal and press the heated meal thus obtaining a further quantity of oil which, although of poorer quality can be utilised in other ways. If

the oil be very viscous or the meal particularly rich in oil, the meal may be re-heated and pressed a third time.

When pressing the meal the pressure should be increased gradually, so that the oil may have time to flow out, otherwise the oil is liable to squirt and carry away with it various impurities such as albuminous matter.

The extraction of oil by chemical solvents depends upon the fact that oils and fats are dissolved by certain liquids, such as petroleum ether, carbon tetra-chloride, tri-chlor-ethylene and other solvents and can therefore be separated from the crushed seed by treating the latter, with one of these solvents.

The extraction can either be carried out in the cold or in the hot; if in the cold, the meal is placed in a series of closed vessels through which the solvent flows on the counter current principle, that is to say the meal that is almost exhausted comes in contact with the fresh solvent. The solution of extracted oil or fat is transferred to a steam-heated still where the volatile solvent is distilled off and recovered by condensation, the traces of solvent retained by the oil or fat being driven off by a current of steam.

Extraction in the hot, which is the usual method adopted, consists in boilling the solvent and passing the mixture of hot solvent and vapour through the meal contained in a separate vessel. The solvent charged with oil is collected in another vessel, where the solvent is again vaporised, leaving the oil; the solvent vapours are condensed and used over again for a fresh charge of meal as in the cold process.

It must not be thought that, because these two processes are so different in principle, they cannot be combined. On the contrary the two are frequently worked together in the same factory, seeds or meal are pressed first and then treated by the solvent process to recover the whole of the remainder of the oil. Although it is possible to obtain only about 85 - 90 per cent. of the oil content of seeds or meal by expression, with extraction it is possible to obtain the whole of the oil.

Having thus described the nature, classification and methods of extraction of a fixed oil or fat, a list of some of the more common ones found in this country will now be given, after which the special details regarding their extraction will be considered.

LIST OF FIXED OILS AND FATS.

Fixed oil or Fat.	English Name.	Malay Name.
Drying oil ...	Rubber Seed Oil ...	Minyak Bijek Getah
	Candle Nut Oil ...	Minyak Buah Keras
Non-drying Oil	Castor Oil ...	Minyak Jarak

Fats	...	Coconut Oil	...	Minyak Kelapa
		Palm Oil		
		Palm Kernel Oil		
		Tengkawang Fat	...	Minyak pokok.

Rubber Seed Oil.—Rubber seeds contain between 56 and 58 per cent. of kernels only, it is advisable therefore to decorticate before pressing, as otherwise the press is partly filled with material which contains no oil. Further the meal or cake from undercorticated seed is unsuitable for cattle feeding purposes.

Candle Nut Oil.—In the case of the candle nut, the kernel is enclosed in a very hard thick shell, which constitutes nearly 70 per cent. by weight of the nut, so that the nuts must be cracked and the kernels extracted before pressing. Cracking by hand with the aid of a hammer is a very tedious process as when cracked the kernel breaks into a number of small pieces all of which have to be picked out with a knife.

Various methods, other than the use of nut-cracking machines, which are unknown so far in this country, have been suggested to facilitate the extraction of the unbroken kernel. The most satisfactory method consists in heating the nuts to a temperature of 130—140°C for about 1½ hours and then plunging into cold water. After soaking for some hours it will be found that about 70 to 75 per cent. of the nuts can be cracked between the fingers and the kernels removed whole or in two pieces, and that of the remaining 30 per cent. all can be broken by tapping with a wooden pestle.

Castor Oil.—The preliminary treatment of castor oil seeds differs somewhat from that of other oil seeds as, the kernels being so soft, the grinding must be very light. It is customary to heat the seeds to about 50° C to reduce the viscosity of the oil and then commence pressing, but if medicinal oil is required seeds should be decorticated first and pressed in the cold. Castor oil cake is one to which the solvent method of extraction can be conveniently applied as there may be as much as 15 or 16 per cent. remaining after pressing, this large quantity being almost entirely due to the high viscosity of the oil.

Coconut Oil.—The preliminary treatment of coconuts and the conversion of the kernel into copra are so familiar that little need be said about them, except that drying by hot air on the counter current principle is preferable to sun drying. Moist copra is readily attacked by fungi, so that care must be taken to ensure that the percentage of water is kept as low as possible, about 4 per cent, otherwise the fungi will cause a large increase in the amount of free fatty acid, with consequent deterioration in the value of the oil.

The copra is ground in a special machine called a disintegrator and then expressed twice at a temperature of about 70° C, either in a hydraulic press or in an expeller and then a press. Two expressions are necessary on account of the high oil content.

Palm Oil and Palm Kernel Oil.—The African oil palm fruit contains two distinct oils, the palm oil, present in the flesh (pericarp) of the fruit, and palm kernel oil present in the kernel, and therefore the separation of the flesh and the nut is the first point for consideration. Further, as there is also present a very active fat splitting enzyme or ferment it is of the utmost importance that fruits be treated fresh and ripe, and also that damaged fruits be kept separate; thus, when bringing the bunches into the factory they should be suspended until required for use, otherwise they will be bruised and large quantities of free fatty acids will develop. An actual instance of this development of fatty acid may be quoted. In March 1921 a quantity of the separate fruits was sent by rail from an estate in the Kuala Selangor district to the Department of Agriculture, about a week elapsing between the time of picking and the time of extraction; when the acidity of the oil was determined, it was found to be about 25 per cent.

The flesh and kernels are separated in a machine called a depulper, which consists of a series of knives and cuts the flesh from the kernel. Before depulping, the fruit is heated and pressed, the object of the heating being to destroy the fat splitting enzyme and thus ensure an oil of very low acidity, and that of the preliminary pressing to remove as much of the oil as possible, thereby preventing contamination with albuminous and fibrous matter from prolonged contact with the pulp. After the depulping operation, the pulp is warmed again and subjected to a high pressure, about 8 tons per square inch, after which it serves as fuel for the boilers.

The extraction of palm kernel oil from the kernels is rather a lengthy and laborious process, as it involves the cracking of a hard nut and the removal of the kernel. Various machines have been constructed to facilitate this process, but up to the present none of them has given complete satisfaction. The kernels after removal from the shells are ground between rollers and expressed in hydraulic presses; the meal is pressed twice on account of the high oil content which is generally between 45 and 50 per cent.

Tengkawang Fat (Borneo Tallow).—This fat is obtained from the kernels of a large variety of plants belonging to the family of Dipterocarpus.

On account of its small distribution the extraction of the fat has not yet been worked out on a commercial scale, the methods at present in use being the primitive native ones, whereby the seeds are cracked by allowing the nuts to germinate, the kernals removed and pressed. The liquid fat is run into moulds made of hollow bamboo stems and consequently the commercial samples have a cylindrical shape (vide Lewkowitsch, Chemical Technology of Oils, Fats and Waxes Vol. II page 491).

Uses of Fixed Oils and Fats.—It is a difficult matter to enumerate all the uses which are found in commerce for the numerous

oils and fats and only the more important ones will be mentioned here.

Name of Oil or Fat.	Nature of Oil or Fat.	Uses.
Rubber Seed Oil ...	Drying ...	Paints, varnishes, soaps.
Candle Nut Oil ...	do. ...	Paints, varnishes, soaps, illuminant.
Castor Oil ...	Non-drying ...	Lubricant, soaps, leather manufacture, medicinal, dyeing industry.
Palm Oil ...	Fat ...	Edible, margarine, soaps, candles, lubricant, tin-plate industry,
Coconut Oil ...	do. ...	Edible, margarine, soaps, illuminant.
Palm Kernel Oil ...	do. ...	Edible, margarine, soaps, candles.
Tengkawang Fat ...	do. ...	Soaps, candles.

From this table it will be seen that the most important uses of these oils are for edible purposes and soap manufacture. This is hardly to be wondered at when one considers the importance of oils as an article of human diet and also the large quantities of soaps required both in maintaining the body in a clean state and in the preparation of clothing and materials, raw wool, cotton, silk, all require large quantities of soap in order to prepare them for weaving.

Only the best quality oils and fats can be used for edible purposes, large amounts of free fatty acid would preclude a fat or oil from being utilised for this purpose, and render it fit only for soaps, just in the same way that a drying oil containing a large proportion of free fatty acid is unsuitable for a paint or varnish.

ESSENTIAL OILS.

Unlike fixed oils and fats, which occur usually only in the seeds or fruit of the plant, essential oils may occur in any part of a plant, the flowers, the leaves, the roots etc.; thus for example, in the case of the rose, the oil is found in the petals and in the case of citronella grass in the leaves. Occasionally, the essential oil is not found as such in the plant, but is formed as a result of the decomposition of some other compound by an enzyme or ferment present in the plant.

Essential oils occur in much smaller quantities in a plant than fixed oils; it is seldom that the yield, calculated on the weight of raw material, exceeds 3 to 5 per cent, frequently it is less than 1 per cent.

Essential oils are very seldom definite chemical compounds, but are generally mixtures of highly complex organic compounds, some-

times hydrocarbons (substances composed of carbon and hydrogen) but more often alcohols, aldehydes and esters.

The proportions of the various constituents vary too, according to the conditions under which the plants are grown; thus a change of soil and climate will often have a marked effect both on the quality and quantity of the oil content.

Essential oils are generally classified according to the botanical orders of the plants from which they are obtained, as it is found that plants from the same family yield essential oils, which have very closely allied chemical compounds as their chief constituents.

It is beyond the scope of this article to deal with such a classification for, if a complete list were given it would be necessary to include every odouriferous plant in Malaya, since they all probably contain some essential oil, in many cases in very minute quantities only.

The only essential oils which will be discussed in this article are two of those belonging to the Natural Order of Graminae, notably citronella and lemon grass oil, both of which are well known in Malaya and with which experiments have been made in the past year regarding their commercial possibilities.

Preliminary Treatment and Extraction.—The treatment to which the grass must be subjected is the same in both cases and consists in steam distillation, a method in which the grass is packed into a boiler through which steam is passed. The oil being volatile, distils over with the steam; the combined vapours are then condensed, when the oil, not being miscible with the water, separates out, rising to the surface as in this case its density is lighter than that of water.

There are certain other details in the technique both as regards preliminary treatment and extraction which deserve attention, as it must be borne in mind that in dealing with essential oils the treatment to which plants are subjected must be carefully controlled.

The price of many essential oils depends upon the delicacy of their odour, and if the extraction be carelessly carried out, the odour may be impaired very considerably.

The grass should either be distilled fresh, or if this is not feasible it should be dried very carefully, and spread out in thin layers until required for use, thereby avoiding all chance of fermentation which would be caused if the grass were piled in heaps.

An effective condensing apparatus is necessary to ensure the vapour of the essential oil and steam being in contact as short a time as possible.

It has also been found that the time of distillation can be diminished very considerably, if the grass be first cut into lengths of six to nine inches.

Uses.—As citronella oil is one of the cheapest of the essential oils, and at the same time possesses a strong odour, apart from its use as a basis for cheap perfumes, this has led to its adoption as a perfume for all kinds of cheap soap which otherwise might possess a disagreable odour. It is also used to a certain extent as a mosquito preventive.

Lemon grass oil is a much more fragrant perfume and in addition to its use as such, it is extensively employed in the preparation of a compound called Ionone, which has an odour similar to violets and forms the basis of artificial violet perfumes.

CONCLUSIONS.—This brief account will be seen to bear out the statement made at the outset to the effect that Malaya is rich in oil bearing plants. It must not be thought that the list is exhaustive as there are many other oils which can be produced, but which have not been described, notably gingelly oil, cotton seed oil, kapok seed oil, and ground nut oil.

The writer is convinced however that there is no reason why after careful experimental cultivation and with adequate financial support, this country should not take a larger part in supplying quantities of various oils both for consumption in Malaya and for export.

RICE MILLING FOR ESTATES.

By H. W. Jack.

UNDER Editorial Notes in the Agricultural Bulletin for January, 1922 the Secretary for Agriculture pointed out the advantages that would result from installing small rice-mills on estates for supplying their coolies with rice.

The purchase of local padi, raw or parboiled and the hulling of it by estates would, apart from the advantages to the buyer, bring great benefits to this country. It would encourage padi cultivation and at the same time, keep in this country a large sum of money which now goes into the pockets of padi planters, dealers and others outside this country.

Furthermore, the use of estate-hulled rice would tend to reduce 'beri-beri' which is a menace to certain sections of the local labour forces,--a question which every employer of labour must have at heart, and of which the most natural solution is the growing of our own rice supply as far as possible.

The hulling of rice by estates is not a difficult practice once the routine is properly established, whether hand or power machines are employed, and the following notes are intended to describe the necessary operations, to stimulate interest in estate milling and arouse inquiry.

The selection of the type of mill is a matter for each estate manager to decide, giving consideration to availability of power and the amount of rice required to supply his labour force. The same considerations apply to the size of store, the capacity of the soaking tank, boiling arrangements and area of drying floor required.

A. POWER MILLS.

1. The Engelberg Rice Huller and Polisher type No. 1:

This mill is obtainable through Messrs. Guthrie & Co., or Messrs. McAlister & Co., and appears to be similar to the "Planters Mill" No. 1 as shipped by Messrs. Douglas & Grant of Scotland whose agents are R. Young & Co., of Penang, except that the latter machine has a larger capacity and requires more power. The "Engelberg" mill has been erected by the Kedah Rubber Company on their estate near Parit Buntar, and the manager, Mr. J. W. Wilson, has kindly supplied all the figures quoted in connection with its erection and working, as actually incurred by that estate. The mill occupies little space, is easily erected, simple in its adjustments, only requires about 6—8 H. P. to drive and does not render the rice deleterious since the

light polishing it receives is hardly more than a means of separating the rice from the chaff.

Initial cost of erection of milling plant on Kedah Estate.

Purchase of mill (agents price) (makers price is $300 gold)	...	...	$750.00
One case spares ...	...	...	100.00
Erection of mill and mill room	...	...	180.00
Shafts, belting, pulleys etc.,	...	...	580.00
Drying floor	...	...	400.00
Soaking and parboiling arrangements	...	...	120.00
Padi store (60 ft. x 18 ft.)	...	...	1,200.00
	Total	...	$ 3,330.00

The cost of erecting the mill included the building of a mill room (12' x 10') adjacent to the rubber factory. In many cases the erection of a separate mill room would be unnecessary, as sufficient space in the factory would be available.

The cost of shafts, belting, pulleys etc., would vary greatly according to conditions obtaining in the factory. In the case quoted it was necessary to put in two counter shafts and the price included the cost of spare belting. In most rubber factories this item of expenditure would be materially reduced or possibly even halved.

A drying floor is necessary to ensure that the padi is thoroughly dry before milling. The cement floor on Kedah Estate covers some 1500 square feet and is ridged, the breadth of each ridge being about 10 feet and the difference in height between ridge and furrow being about 4 inches.

The padi is soaked and parboiled prior to milling to clean the padi and to render the hulling operation the easier. Soaking is done in a plain cemented tank having a capacity of 12 bags of padi and an outflow pipe at the bottom for changing the water. The arrangement for parboiling is simple and effective. Three large shallow iron pans (kwali) each capable of holding one bag of padi are mounted on a circular brick and cement oven, one fire being sufficient to heat the three pans at the same time, the whole arrangement being under cover.

The padi store is built mainly of bricks, cement and corrugated iron sheeting and would possibly cost more on other estates, where no clay suitable for making bricks is available and where the estate labour cannot make bricks or do the building.

On Kedah Estate, this mill is run for 2½ hours daily, and produces 150 gantangs of clean rice, (approximately 950 lbs) the padi being put through the mill twice, i..e. the "outturn" is a milling terms per hour of clean rice is roughly 60 gantangs.

The cost of milling, including soaking, parboiling, drying, milling and bagging but exclusive of depreciation of mill or European supervision, is 1.2 cents per gantang of rice, and the percentage of rice obtained from padi averages 44 (by volume).

The cost of padi delivered on the estate this season was 14 cents per gantang, so that the cost of rice works out at 33.7 cents per gantang as follows:

2⅓ gantangs padi	... ...	32.5 cts (actual)
Manufacture	... ...	1.2 cts
	Total ...	33.7 cts

The mill has been running daily for over six months and no repairs have yet been necessary.

In using this mill the routine may be briefly summarised as follows:—

(1) Soak padi 24 hours, changing the water at least twice.
(2) Parboil padi for 20 minutes, stirring all the time.
(3) Dry padi thoroughly (not less than 24 hours).
(4) Mill.
(5) Mill again.

2. The Engelberg Huller.

This machine is sold by the makers for $215 gold (local agents about $550.00) and is in all points the same as the one described above except that it does no polishing or separating of the rice from the chaff and thus necessitates the use of a winnower. Indeed a winnower, though not essential, is advantageously used with the Huller and Polisher also.

Hand winnowers are cheap, durable and effective and most Chinese carpenters can make them for $30—45.00, or failing the local "tukang," they can be made to order for estates through the Agricultural Department.

Power winnowers can, of course, be used also, but they are expensive and no more effective than hand machines.

3. The Improved Under-Runner Hulling Mill.

This machine is also sold by Messrs. Douglas & Grant (catalogue page B. 3.) through their local agents and would appear to be effective, though the writer has had no experience with it.

Like No. 2, above, it requires to be used with a winnower and a separator.

It is sold in four sizes of capacities varying from 300 900 gantangs of padi per hour, that is, equal to an outturn of 120—400 gantangs of clean rice.

The power required for the efficient running of the smallest size is only 2 H.P. and of the largest size 4½ H.P. and the machine costs approximately $600.00 (probably exclusive of commission.)

B. HAND POWER MACHINES.

The best of these is the Improved Hand Power Rice Huller as shipped by Messrs. Douglas & Grant (catalogue page R. 1) and is obtainable through McAlister & Co., or R. Young & Co.

This mill is a combined huller and winnower and is very effective if used in conjunction with a hand power "compartment separator" as specially designed for it by the makers. The "Compartment separator" divides the hulled from the unhulled rice after the first milling and the unhulled rice is passed through the mill a second time.

The mill is very simple in design, very compact, easily adjusted, strongly constructed and practically foolproof. The hopper is fitted with an efficient feeder which delivers the padi to the hulling discs in an even stream and a neat winnowing attachment blows away all the husk.

This mill is very suitable for small estates not requiring a large amount of rice per day as its outturn is only some 15 gantangs of rice per hour. The hand labour involved in working it is very light and it might also be adapted so as to be driven by a light motorcycle engine as the power required is less than 1 H.P.

Before using this mill care should be taken that the padi is clean i.e. free from foreign particles such as pieces of stones, nails etc., which are liable to damage the grinding discs.

The price for the machine is $400 approx: and spare parts including grinding discs can be supplied.

The hand power "compartment separator" designed for use with the mill costs $500/- and by using it, the grinding discs of the huller can be set so that practically no rice is broken, unless the padi used is of very inferior or mixed quality. The separator can deal with some 25 gantangs of milled rice per hour.

Any of the above-mentioned machines can be used for raw as well as for parboiled padi, but slightly more breakage of rice is usually experienced.

THE TREATMENT OF BUDDED HEVEA SEEDLINGS.

By J. N. Milsum.

In a previous paper (1) it was stated that exact information as to the best system to be adopted to establish budded rubber stumps in the field was not available. Recent experiments conducted at the Kuala Lumpur Experimental Plantations have thrown considerable light on this and other matters connected with budding Hevea, and it is considered advisable to publish the results so far obtained. In addition, much useful information has been published in the 'Archief voor de Rubbercultur' (2), wherein Mr. F. W. Donkersloot discusses the vegetative reproduction of Hevea as an estate practice in Sumatra.

Time For Budding.

The highest percentage of successes in budding is obtained after the wintering period, when the sap is active. Budding should not be undertaken just before and during the wintering period of the mother trees. Equal success was obtained during June, July and August, but it was found that stumps budded during the last mentioned month were as far advanced as those budded earlier, when examined in October prior to transplanting. It is to be appreciated that though budding may be performed during the greater part of the year, the operation should be timed to secure stumps in fit condition for transplanting during the rainy seasons usually commencing in September and March. No budding should be done during rains as the possibility of moulds entering the wound is increased.

Removal of the Stumps from the Nurseries.

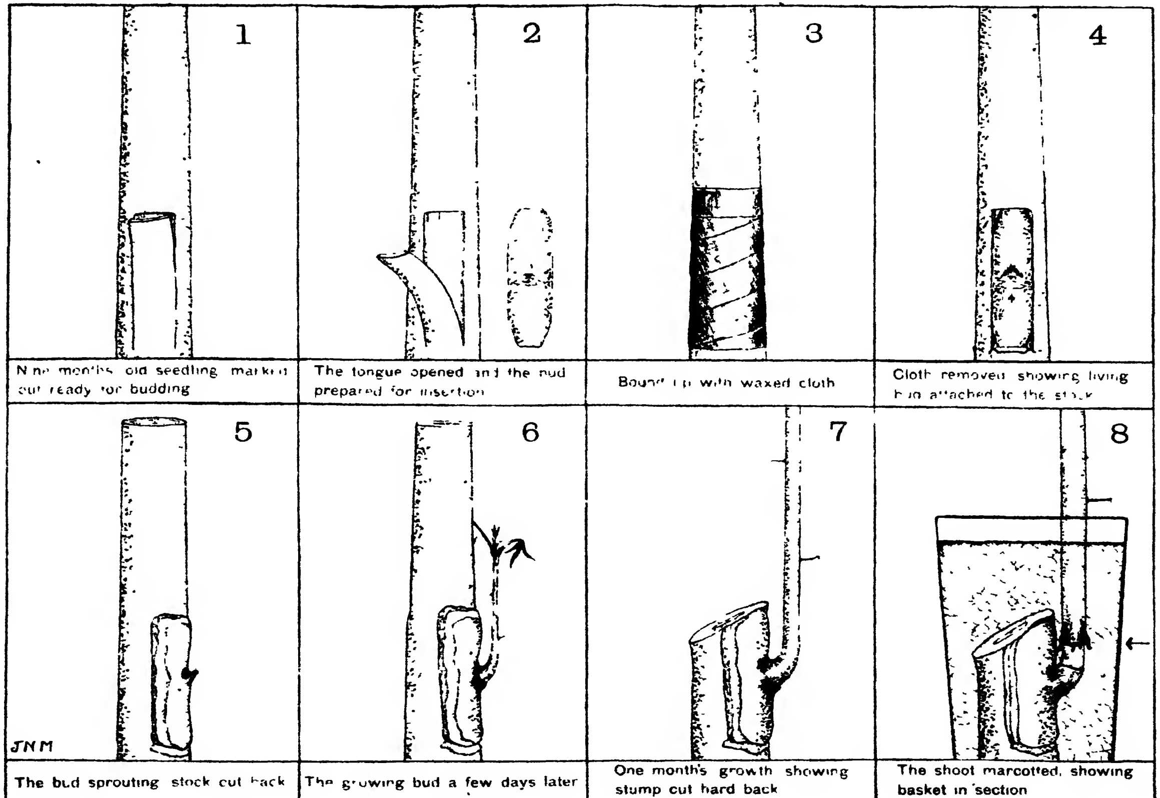
After the bud has become firmly united to the stock, it remains in a dormant condition until some action is taken to force it into development. This may be accomplished by cutting off the upper portion of the stock to within one foot of the dormant bud. The time that may elapse between the removal of the upper part of the stock and the time the bud commences to grow varies considerably according to circumstances. It is usually from 3 to 6 weeks, but frequently a number will take as long as 6 months. The buds obtained from the upper branches of the mother trees have a better sap circulation and usually are more active than those obtained from the lower branches.

The most favourable period to transplant the stump to the field is when the shoot has grown from 1 to 3 inches long, but before any leaves have been formed. Once the eye has commenced sprouting,

1) Agricultural Bulletin, F.M.S., Vol. IX No 2.

(2) Volume 5. No II, p. 509 'De Vegetatieve Vermenigvuldiging van Hevea als Kebonpraktijk'. (In Dutch only.)

TREATMENT OF BUDDED HEVEA SEEDLINGS.



growth is very rapid and it is most important to get the stumps planted in the field without delay. After leaves have been formed, it is necessary to lift the stump with a ball of soil or allow it to remain in the nursery until of sufficient size to treat as in the case of ordinary seedling stumps. The taproot may be shortened and some of the side roots cut away, but as little damage as possible should be done during transplanting.

In Sumatra, wooden frames are employed for removing budded stumps from the nurseries. By this means it is possible to transport 1200 stumps in a Ford truck in one journey. The stumps are covered over and kept as cool as possible; they should be shaded from direct sunshine.

The portion of the stump above the shoot is used as a handle in planting. A few months later, when the stump is established, this piece of wood is sawn off transversely. Donkersloot states that there is really little reason to cut away the wood from above the bud when the shoot is formed as this will fall away later as in the case of seedling stumps. He recommends coating the cut surface with yellow paraffin wax. This substance is said to be far superior to tar in all such operations and it has been found to assist the cambium growing over the wound.

All growths appearing from the base of the stocks must be removed regularly. It is advisable to arrange periodical inspection of the fields for this purpose. Where heavy winds are prevalent, it is often necessary to place stakes as supports to the shoots. This is especially necessary in the case of large stumps, which cause the shoots to become leafy and topheavy.

Pruning is frequently required as budded trees have a marked inclination to branch low down. Our knowledge of the subsequent behaviour of budded trees is at present incomplete and further investigations are necessary in this respect.

Marcottage.

One of the reasons advanced against the planting of budded stumps from selected trees is that it is at present uncertain whether the latex producing qualities of the trees will remain constant when the trees are on roots other than their own. By the use of marcottage it is possible to have the young trees on their own roots. The operation is quite simple and a high percentage of successes is obtained. The budded stumps are allowed to remain in the nurseries and are marcotted one year after having been budded. Strong stumps may be employed as stocks as the understem is only a temporary feeder.

A ring is made at the base of the scion as close to the junction of the stock as possible. A narrow piece of bark, ½ inch broad, to the depth of the cambium is removed. A bamboo basket, with the bottom cut away, is placed around the marcot, half under the soil and the other half above. The basket is filled with light rich soil and, in the absence of rain, watered daily. In four months' time roots

will have been formed, and the growth is severed at the junction with the stock, and planted out in the field.

Further investigations are necessary before this system should be employed as an estate practice. Mr. Maas, the Agriculturist at the General Experimental Station of the Algemeene Vereeniging van Rubber planters ter Oastkust van Sumatra, Medan, considers it practicable. Provided the shoots have a good root system before transplanting to the field, there should be few after difficulties. It is obvious that marcottage will result in considerable extra expense and also more time will be necessary before the trees become established. As to whether this is justified by results is a matter for further enquiry. The future prosperity of the rubber producing industry will depend largely on low cost of production. This may be achieved by increased yields.

Bud Wood.

The number of suitable eyes for budding, from any one mother tree, is variable. Ten year old trees examined at the Kuala Lumpur Experimental Plantation showed on an average six suitable eyes to every foot of growth in the upper branches. Donkersloot states that a mother tree will give 500 to 2000 eyes suitable for the purpose of budding. The average number is about 1000 eyes. In selecting the bud wood from the mother trees, care should be taken to use the bud from the thick branches for the largest stumps and buds from thin wood for the smallest.

Branches for the supply of eyes may be kept for a number of days provided the wood is kept cool and away from the sun. Thick branches keep for a longer period than thin, which are liable to dry out early. Experience in Sumatra shows that thick branches will keep for 14 days without any harm to the eyes. They may be kept for a longer period by storage in chests containing damp coconut fibre, charcoal, or sacks. It is necessary to clean out the chests after ten days to make certain that no fungi or moulds are entering. It is known that considerable quantities of bud wood have been imported into the Peninsula from Sumatra, for use in budding on new plantations.

Budding in the Field.

The experience the writer has had of budding in the field has so far not been very satisfactory. This is thought to be due to the fact that the stumps have been too old when budded, and though in the majority of cases, the actual operation of budding has been reasonably successful, the subsequent behaviour of the stumps has been often diappointing. It is to be appreciated that the growth forced from a large stump frequently becomes topheavy and liable to be broken by the wind. This danger may, to a great extent, be minimised by staking the bud shoot. It has been noticed that the foliage on such growth is very delicate and cases of leaf disease have been reported. There appears to be the possibility of serious trouble in this respect.

A further difficulty is encountered when it is desired to re-bud stocks that have failed to sprout after having been cut back. Nine months or more must elapse before fresh growth is made and it is then uncertain what percentage of success may be obtained in the subsequent budding.

In the case of young seedlings in the field, there would appear to be no reason why budding may not be undertaken with success. The coolie should be taught to work with his back to the sun and, after budding, the seedlings must be shaded with circular screens of 'lalang'. On the Holland American Plantation Company's property at Kisarin, tapioca has been used as a shade with much success Several tapioca cuttings are planted around the stump in a circle. five feet in diameter, about four months before the stumps are required for budding. After the buds have sprouted, the tapioca is removed before the plants have had time to form tubers and impoverish the land. Further investigations are necessary to ascertain the relative success of budding seedlings in the field and in nurseries. For the present, the writer favours the latter method, mainly because a regular stand of trees is thus obtained and selection of planting material is possible up to the actual time of transplanting the sprouted stumps to the field.

Planting Distances.

In planting budded Hevea stock, it is to be appreciated that as each tree is theoretically of equal value from the standpoint of latex production, thinning out is not resorted to. On land from which all stumps and roots have been removed it would appear possible to plant 70 to 80 trees per acre, with a reasonable certainty of having a sufficient stand of trees when in bearing. On uncleaned land with the danger of root disease, allowance must be made for loss and it will be neceseary to plant closer. Donkersloot states that the usual number of trees planted per acre is 84.

KAPOK.

By D. H. Grist.

(*Re-print from the Straits Times of 8th July 1922.*)

THE cotton tree (*Eriodendron anfractuosum*) known to the Malays as kabu kabu or ka-kabu is sufficiently familiar to residents in the Tropics to need little description. The tree is readily recognisable by its tall straight trunk, bearing at intervals horizontal branches, which during the fruiting period are devoid of leaves. The value of the tree and its suitability for cultivation in Malaya are less well-known facts.

Kapok is used very extensively as a "filler" for mattresses, pillows and other articles of upholstery, and on account of its buoyancy, and non-matting qualities, it is superior to almost any other filler. Moreover, if the kapok has become hard with much use, it rapidly regains its excellent properties when exposed to bright sunlight. Kapok has also found extended uses during recent years in life-saving apparatus, life-belts, buoyancy cushions and ocean jackets. Its market is also likely to extend when its value is better appreciated as a filler for surgical dressings. For this purpose it possesses the requisite advantages of lightness, elasticity, dryness and suitability for dry sterilisation. Up to the present, kapok has not been found suitable for spinning, owing to its short fibre and extreme brittleness.

Kapok is found in practically all tropical countries, and until recent years had not been considered a crop suitable for plantation conditions. Java practically supplies the world; the exports from that country in 1921 amounted to over seventeen and a half thousand metric tons, exported mainly to the United States of America, Holland, Australia and England. Thus in 1921 Java received about one and a half million pounds sterling for kapok supplied to other countries. Other exporting countries are the Philippine Islands, Ceylon, India, and Venezuela (where the finest quality is said to grow.) The standard kapok comes from Java and is known as Prime Samarang. The prices vary from 4d. per lb. for Indian kapok to 13d. per pound for that originating from Java and Venezuela. The interesting point in the production of kapok in most countries is that practically in every case the cultivation is in the hands of natives, the foreigner managing the marketing.

A census of the trees in the Federated Malay States and the Straits Settlements has been made with the result that it is ascertained that although almost all districts contain trees, the amount of kapok obtained is insufficient to meet the local demand. The exceptions to this were in Lower Perak, Kuala Kangsar and Krian Districts, which together contained about sixty thousand trees. The purchase of kapok by Chinese has yielded such poor returns to the Malay growers that the latter sell but a small proportion of their crop, and much of the

kapok is allowed to rot in situ. There are about 10,000 trees only in the Straits Settlements. Perak holds out the best hopes of establishing a native industry in this commodity, and the Department of Agriculture is taking steps to organise this at an early date.

Kapok will flourish in a wide range of soils, but those of a light friable nature, allowing easy development of the somewhat sparse root system, are preferable. In this country, the alluvial soils along river banks give the best returns, after which a sandy loam is suitable. In Java, the finest crops are obtained from the well-weathered volcanic soils of Samarang. Whatever be the soil, the drainage should be good, although occasional floods over the area do not appear adversely to affect the trees. In fact, the Malays state that the tree flourishes best on land periodically flooded. Hill land or any land very subject to white ants is less suitable, as white ants are the most serious pest of kapok trees in this country.

The methods of cultivation of kapok must be judged mainly from general agricultural experience rather than actual knowledge of plantation conditions for this crop, for apart from new plantations in the Philippine Islands and in Java, the crop has not been planted on a large scale.

The land should be well cultivated, and kapok seed planted, "seed to stake," there being two or three seeds per hole. The best planting distance is twenty feet square: which allows just sufficient room for the branches, and space for other cultural operations between the rows. Some writers advocate raising the seed in a nursery, but from his own observations, the writer doubts whether such a course is sufficiently compensated by increased yield. Growth is very rapid, and a selection of the particular seedling to be left must be made at an early stage. In so far as the kapok tree is concerned, no further cultural operations are considered necessary, although it is of advantage to the tree to retain the soil in a state of cultivation. It must be remembered too that when the tree comes into bearing, the ground must be fairly clear to facilitate harvesting operations. Kapok may also be planted from branch or stem cuttings, but this practice carries with it many objections. The trees thus propagated will commence bearing about one season before trees obtained from seed, but such trees are more liable to the attack of white ants, are more likely to fall in high winds owing to the absence of tap-roots, and have a much shorter life than trees obtained from seed.

The trees commence bearing in about four years from planting, when a small crop of perhaps fifty pods per tree might be expected. Thereafter the increase in crop is very rapid. Fruiting takes place once annually, after the rains. At this season the leaves drop off and for three or four months the tree is without foliage and is ripening its fruit. One can but estimate probable crops. A plantation of about eight years would probably give an average of 400 pods per tree. The life of the tree, planted from seed, may be as much as fifty years. The writer has seen trees of 35 years of age yielding over 1,000 pods per annum, and under plantation conditions such yields should be quite possible in younger plantations.

In Java, the pods are not harvested, but are picked from the ground immediately they have fallen. In Malaya, with more uncertain seasons, ripe pods are more liable to persist on the tree, and must therefore be harvested before rain and dew deteriorate the floss. This does not present great difficulties, but care should be taken to insure that only ripe pods are harvested.

The following is an average composition of dry ripe pods.

Husks and Placentas	... ...	44 per cent.
Seeds	... ...	35 „
Floss	... ...	21 „

It is generally estimated that one hundred pods will produce 1 lb. of clean kapok.

Kapok seed contains over 20 per cent. of oil. Large quantities of seed are exported annually from Java. In 1912, nearly 300,000 piculs of seed were exported from Java, valued at about $600,000. The oil is employed in soap making and as an adulterant of other oils. The cake or meal, after expression of the oil from the seed, is a useful cattle food or fertilizer.

Much of the kapok from Java is cleaned or partly cleaned by hand; but in order to obtain first class floss, its subsequent treatment by machinery is necessary. The universal method of cleaning by natives is to place the pods. after removal of the husks and placentas, into a barrel and to cause to revolve a forked bamboo in the kapok. This opens up the floss so that the seeds fall to the bottom of the barrel. All the types of machines work on the same principle. Instead of the barrel, the machine consists of a chamber set horizontally or perpendicularly. Through this chamber runs a shaft provided with blades. From the sides of the chamber other blades extend, placed in such a way that they pass an inch or so in front of the revolving blades of the shaft. In the Philippine bulletin on the Kapok Industry three such machines are described, but there is a lack of detail of makers of such machines and cost of same. Messrs. Ernest Lehmann, Engineers, Manchester are the makers of a machine for ginning cotton, which they claim is also adapted for ginning Kapok. This machine can be obtained for hand or belt power. The Hand Machine will produce about 12 lbs. of clean floss per hour, while the largest size Belt Power Machine will produce about 1200 lbs. of clean floss per day. The power required for the belt machine is very little—not more than 1 h.p. The prices of such machines vary from £60 to £92. The Bley kapok ginner is said to be one of the best machines so far invented: It requires one-half to one horse power for its operation and is claimed to clean 217 kilos per hour. This machine was exhibited and operated at the Surabaya Fibres Congress and Exhibition 1910 and was awarded first prize. It may be obtained from Lindetevas Stockvis, Batavia for about $200.

It is urged that kapok prepared for export must be free of seed, and for this purpose hand labour will prove too expensive.

Messrs. Lehmann also advertise a kapok cleaning machine. This is constructed for the purpose of opening out kapok, which has been gathered from the field and stored in the godown, or which

has been press-packed in bales and exported. It is said to open out every particle of the material and to free it of all dust, knotty matter, hards, lumps and other impurities, leaving the material in a light and loose condition, ready for upholstery and other purposes. These machines are made in two sizes, one for steam power and the other for hand power. The former will treat about 2,000 lbs. daily; requires 1 ¾ h.p. and costs £305. The latter treats 200 lbs. daily and costs £110. It should be pointed out that the machine described above is not a necessity from the producers point of view, as the mills in England treat the kapok in this way if not already so treated.

Kapok is exported in bales, and for this purpose a baling machine is essential. Balers cost from £24 to £100 and more. Interested readers are advised to correspond with the Department of Agriculture on this point or to obtain information on balers from Messrs. Hollings and Guest, Ltd., Timble Mill Lane, Birmingham,

Baling is essential to economise in shipping freights. The size of bale prepared varies according to the market to which the kapok is to be exported. For European shipment the bale is 1.70 piculs or 217.6 lbs.; for Australian shipment 1.20 piculs per double bale and 0.80 picul per single bale. Baling is best pressed into sacking or matting and bound with fibre.

There is a world-wide demand for kapok. The principal countries of import are Holland, America, Australia and New Zealand, and England. The Department of Agriculture is in a position to place sellers of kapok in touch with some fifty buyers in all parts of the world. The present price of Prime Samarang is about 12½d. per lb. Second and third quality kapok is placed on the market at present prices from 4d. to 9d. per lb.

The object of this article is to bring to the notice of planters and others the commercial possibilities of the cultivation of the kapok tree in Malaya. Kapok is one of the few crops which does not appear to have been affected by the slump: the price for many years has been steady, and with constantly increasing demand as its floss becomes better known and more appreciated as a filler, together with the possibility of new uses, it appears probable that the market will remain firm for a considerable time. The outlay in establishing the crop and upkeep charges are small, and the machinery required, for preparing the floss for market, inexpensive. Moreover, any estate provided with machinery can attach kapok cleaning machinery to their shaft, as the horse-power required is small. The great advantage of kapok cultivation is that the land, in addition to bearing mature kapok trees can, by reason of the little shade thrown by such trees, be utilized for a wide range of additional crops. In Java, vanilla, coffee, cocoa are frequently grown in this way. In Perak, limes are frequently so grown with success. The possibility of establishing a rotation of fibre crops under kabu is worthy of consideration. The more fibre crops that can be grown in conjunction with kabu the better, as the balers are more constantly in use.

The quality of fibre from Malayan trees compares very favourably with that produced by Sumatra, and it is probable that with better local methods of cultivation and the introduction of machinery, this country can produce kapok equal to that of Java.

The Department of Agriculture has extended their enquiries over many months on the cultivation of kapok, machinery, marketing, supply and demand, prices etc., and is in a position to give those interested more detailed information than is possible in this place. Enquiries will therefore be welcome at any time, and personal interviews arranged for as far as possible. All enquiries should be addressed to the Secretary for Agriculture, Department of Agriculture, Kuala Lumpur.

ENTOMOLOGICAL JOTTINGS.

By G. H. Corbett.

Plesispa nipa, Maulik.

This insect, which is a new species of Hispid beetle, was found near Malacca on nipah (*Nipa fruticans*) and rembia (*Metroxylon sagu*).

Plesispa reichei, a pest of young coconut palms and *Plesispa nipa* resemble each other so closely that they may be easily confused. There are structural differences but if the species are compared it will be noticed that the thorax and abdomen of *Plesispa nipa* are reddish whilst the thorax is yellowish and the abdomen blackish of *Plesispa reichei*.

Plesispa nipa causes similar injury to nipah palms as *Plesispa reichei* to coconut palms.

It is interesting to note that whilst the eggs of *Plesispa reichei* are always laid singly, those of *Plesispa nipa* are deposited in groups.

Astychus Chrysochloris.

This weevil is generally distributed throughout Malaya. The insects are golden green in colour, but, on account of the golden scales being rubbed off, some appear greyish black.

The adults eat the leaves of a variety of plants such as rubber, limes, and castor, but the cause of the damage is frequently unobserved owing to the " hide and seek " habits of the insect on the leaves.

The eggs which are laid in the soil hatch in about seven days.

A female observed laying eggs in the soil in the Insectary deposited 16 eggs in 21 minutes.

Dysdercus Cingulatus.

This insect is one of the cotton stainers but besides cotton is frequently seen on ladies' fingers, roselle, and similar plants.

The yellowish eggs are laid usually in the soil and hatch in about one week. The time taken for the emerged wingless nymphs to become winged adult bugs is about seven weeks.

The bugs are conspicuous and may be collected by hand or shaken into a bag fitted with a tin funnel.

Leaves of ladies' fingers showing holes in the tissue together with specimens of *Dysdercus cingulatus* were received by the Department, and it was thought that this insect was responsible for the damage.

Both nymphs and adults are only able to puncture the tissue of plants and derive nutriment by sucking the sap. They are not capable of eating holes in leaves.

The injury to the leaves was probably caused by a beetle which hides during the day time in the soil.

ATLAS MOTH. (*Attacus atlas.*)

A female of the Atlas moth which was caught in the field during the month deposited 507 eggs.

The eggs are brownish in colour and should be hand collected. The caterpillars are frequently found on soursop, candle nut, guava, camphor and limes.

RUBBER FLOWER GEOMETRID. (*Hemithea costipunctata*).

Caterpillars of this moth are being collected daily in The Gardens, Kuala Lumpur.

They are difficult to detect but if the flowers are carefully examined their presence should be observed.

A few other caterpillars and bugs have been noted on the inflorescences.

LIMES.

Numerous insects injure the foliage and fruit of lime trees.

A plant which is thoroughly healthy will often escape attack or will suffer comparatively little, whilst a weakly one will be attacked more readily and its fruit reduced a greater amount.

It is not suggested that healthy lime trees will not be attacked by insects, but there is no doubt that the reason why some lime trees are badly attacked is that they are growing in unhealthy conditions.

Cultivating and manuring of some of the lime trees in Malaya should help the trees to withstand to a greater extent the ravages of pests.

RHYNCHOPHORUS SCHACH.

This beetle pest of coconuts in Malaya in Entomological writings will be referred to in future as the "Red Stripe" weevil and not the "Red" Weevil, for the obvious reasons that it is not red but black and possesses a red stripe on the dorsal surface of the prothorax.

In connection with the work on this insect, a one day old grub placed in the end of a cut petiole of a coconut leaf at a distance of one yard from the trunk ate its way down inside the petiole and was found in the trunk.

A PADI "BORER."

The caterpillar "borer" of padi, which is being investigated in the Krian district and has not been previously recorded in Malaya, has been identified by Dr. Guy A. K. Marshall as *Diatraea Auricilia Dudgeon.*

The eggs of this insect which are laid in groups on the leaves of padi have been observed parasitised.

CANDLE NUT TREE. *(Aleuritis sp..)*

"Slug" caterpillars of different species have been noted damaging this economic plant:

PRODENIA LITURA.

Six hundred and one caterpillars hatched from one egg mass of this insect collected from castor.

This insect has a large variety of host plants. The eggs are laid in groups on the leaves and are made conspicuous by a covering of buff coloured hairs derived from the body of the female moth.

The eggs hatch in about 3 days and the caterpillars live gregariously for a short time before separating to different parts of the plant. When the caterpillars are full grown, usually in about twenty days, they enter the soil for pupation. The adult moth emerges from the pupa in about seven days.

Collection of egg masses and caterpillars should be done on their first appearance. Spraying with an arsenical spray might be necessary to control this insect.

THE GREATER COCONUT SPIKE MOTH.

Observations concerning the habits and control of this important pest of coconuts have been occupying the attention of the entomological officers for the past few months.

One of the causes for the spike failing to produce nuts is the caterpillar of the greafer coconut spike moth.

The moth has a wing expanse of about ¾ inch. The fore wings are green between the veins and red above the veins. The hind wings are golden yellow in colour.

The adult lays her eggs singly on the spikes mostly in places where the buds overlap one another. They resemble the colour of the spike. They hatch in from three to six days.

Preliminary breeding work indicates that the minimum length of time from egg to adult is 28 days and the maximum 43 days.

The larvae usually feed on the male flowers of the spike. They are active and form a gallery of excrement through which they advance or retire when disturbed.

Pupation takes place on the spike or on the spathe or at the base of the spike where, owing to the fallen buds collecting there, the larvae are able to develop.

All badly attacked spikes should be entirely removed and burnt and the trees should be cleaned of accumulated fallen buds.

Spraying and dusting experiments are being carried out with a view to the control of this insect.

THE LESSER COCONUT SPIKE MOTH.

The damage caused by this moth to both female and male flowers is done before the spathe opens.

The white cocoons may be seen at the base of the spike and occasionally on opening the spathe, moths emerge.

As far as the writer is aware injury to the inflorescence of the coconut at this stage caused by the caterpillars of this moth has not been previously recorded.

THE PADI "FLY"—(*Leptocorisa varicornis*).

This well known pest of the ripening padi grain is under observation at present, and considerable information has been accumulated.

Besides padi this insect has been successfully bred from egg to adult on the ripening seed of various grasses which may be commonly found in padi areas.

Insects have reached the adult winged condition after the nymphs emerged from the eggs on the forming seeds of *Panicum cotonum* in 16—18 days, and *Paspalum conjugatum* in 19—20 days.

Leptocorisa feeds on grasses especially when there is no ripening padi in the field and in the control of this insect it is particularly advisable to prevent the grasses in the vicinity of padi flowering.

NOTES ON "RUST" IN SMOKED SHEET.

BY B. J. EATON.

CAUSE OF RUST:—The defect known as "Rust" on smoked sheet is caused by an exudation of the soluble non-caoutchouc serum products in the latex, which come to the surface, while the sheet is contracting, after being machined, during the early stages of drying and smoking.

The aqueous liquid, which exudes from the interior of the freshly machined sheets, settles especially in the diamond depressions of ordinary diamond marked sheet and evaporates in these, forming a thin film which sometimes become glossy when the sheet is smoked and dried.

This film is very thin and cannot be removed by washing after the rubber is dry, since it adheres to the rubber.

On stretching or scratching the sheet however, the film is broken up and appears as a "rusty" incustation or powder on the surface. The film is usually so thin that no particles can be removed from the surface.

PREDISPOSING INFLUENCES:

(a) "Rust" is more likely to occur on smoked sheet, if a very concentrated latex is used in the preparation of the sheet, since the concentration of the serum, which exudes from the interior, is greater.

(b) "Rust" is likely to occur especially on the lower sheets and on the edges of such sheets, if a big pile of sheets is stacked on a table, after being machined.

(c) "Rust" is likely to occur if the sheets are not allowed to drip and are not washed or soaked in water after being machined and allowed to drip before placing in the smoke house.

(d) "Rust" is probably also seasonable to a certain extent.

REMEDIES:—The predisposing influences to the occurrence or formation of rust, as given above, will indicate the remedies to be applied which are as follows:-

"If the rust is due to the use of too concentrated a latex, dilution of the latex must be effected."

"It is recommended that the final latex used in the preparation of sheet should contain between 1¼ and 1½ lbs. of dry rubber per gallon."

Sheet from strong latex is preferable, from the point of view of intrinsic quality, but since the brokers object to "rust", it is essential that the producer should dilute his latex for the manufacture of sheet, if "rust" occurs.

The practice of piling sheets in a large stack on a flat table after machining should be avoided. All sheets should be hung separately on a rack, immediately after machining, so that the watery serum, which exudes as the sheet contracts, can drip off.
After allowing the sheets to drain as above for about an hour they should be soaked in running water or placed in two or three changes of water in large tanks and again allowed to drain on racks for about an hour, before being placed in the smoke house.
The smoke house should be ventilated and drv fuel should be used for smoking. "Rust" can be eliminated by placing the sheets, after machining, to dry in the sun for an hour or two before placing them in the smoke house. This practice however is not recommended if the "rust" can be eliminated by the washing method described above.

NOTE :—According to some authorities "rust" is produced by the decomposition of the serum products which exude and remain on the surface of the sheet. This point however is not very material and is not believed to be the cause in all cases of rust. The exudation of the serum and its evaporation on the surface is sufficient to cause "rust", irrespective of any bacterial decomposition of the film.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of February, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	143.00	79.7	88.46	71.78	16.67	75.3	.790	72.2	77%	...	30.93	15.52
Pahang, Kuala Lipis	...	...	80.37	88.87	73.0	15.87	75.43	...	...	...		2.76	.60
Johore, Johore Bahru	...	...	...	88.25	71.58	...	...	...	...	...	...	9.37	2.97
Singapore, Kandang Kerbau	1014.7	152.7	84.7	84.6	72.6	...	77.1	...	...	...	Calm.	7.79	2.18
Malacca, Durian Daun	1017.9	136.00	81.	88.	73.	15.	77.	.893	...	81.	N.	3.64	.92
Negri Sembilan, Seremban	...	146.	80.6	90.1	72.5	17.6	76.	.813	72.9	77.8	N. W.	2.60	.76
,, Kuala Pilah	...	156.3	81.2	89.1	71.4	17.7	77.2	.860	76.3	82.1	...	3.37	1.66
,, Port Dickson	...	161.6	81.1	86.1	73.4	12.7	77.5	.859	74.6	78.9	...	6.86	5.11
Selangor, Kuala Lumpur	...	...	81.9	89.8	72.2	17.6	76.5	.800	71.5	75.	N. E.	9.79	1.99
,, Klang	...	...	79.7	85.1	74.3	10.8	75.6	...	..	...	...	3.47	1.49
,, Kuala Selangor	...	...	...	90.0	69.9	20.1	...	...	...	...	...	5.10	1.18
,, Rawang	...	...	...	90.2	72.1	11.1	...	...	...	...	...	3.56	1.08
Perak, Telok Anson	...	...	81.61	92.	70.	22.	77.03	.868	...	81.	...	8.74	1.96
,, Ipoh	...	...	81.69	95.	67.	28.	76.18	.828	74.60	77.	...	4.90	1.22
,, Taiping	...	...	80.78	92.	70.	22.	78.39	.939	...	91.	...	10.31	2.20
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	21.73	3.50
,, Parit Buntar	...	...	82.56	93.	71.	22.	77.80	.890	...	81.	...	4.64	1.53
Penang, George Town	1007.6	162.	82.8	93.	70.	23.	78.6	922.3	70.	83.2	N. W.	2.51	.66
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	5.19	2.10
Perlis, Kangar	...	...	..	90.	71.57	18.43	...	...	...	...	...	4.51	2.70

THE

Malayan Agricultural Journal.

Vol. X. MARCH, 1922. No. 3.

EDITORIAL NOTES.

STAFF

Mr. F. R. Mason reported his arrival on 6th March and assumed duties as Assistant Mycologist.

CINCHONA.

This number of the Malayan Agricultural Journal contains a report by the Assistant Economic Botanist, on the Cinchona Industry in Java. At the present time the production of quinine is in excess of the consumption, but there appears to be no reason why British Malaya should not endeavour to produce enough for its own consumption, instead of paying away annually a considerable sum of money to other countries for what can probably be produced locally.

An investigation of certain areas in Malaya likely to prove suitable for Cinchona is desirable and will be made.

PLANTING MATERIAL.

The Department of Agriculture is now in a position to supply 50,000 African Oil Palm Seeds (*Elaeis guineensis*). Price $30/- per 1,000 seeds, F. O. R. Kuala Lumpur Station.

DISTRIBUTION OF KAPOK TREES IN MALAYA.

A rough census of kapok trees in the Peninsula has been made, with the result that apart from the Districts of Kuala Kangsar, and Lower Perak and Krian, in no district are kapok trees found in sufficiently large numbers to satisfy the local demand.

The trees in Lower Perak and Kuala Kangsar are mostly to be found along the banks of the Perak River and are in a promising condition. Those to be found in Krian are of very poor growth, due no doubt to the fact that their roots have little chance of development as the trees are generally found on the "battas" of the padi fields.

The significant fact is that kapok trees are found in a flourishing condition in almost every district, which leads one to the conclusion that Malaya is suitable for the cultivation of this plant; and that it may be grown sucessfully in a wide range of soils.

FIBRE BALING PRESS.

A fibre baling press is available at the Department of Agriculture. Managers or proprietors of estates and others who may wish to prepare experimental bales for export can have such fibres baled at the Department on application to the Secretary for Agriculture.

The baling press has the following internal dimensions:—Length 3 ft. 7 inches. Breadth 2 feet 8 inches. Depth 3 feet. A pressure of 100 kilogrammes per square (= 1422 lbs. per square inch) can be applied on the ram.

Bales of Roselle fibre weighing 220 lbs. and measuring approximately 13 cubic feet (3ft. 7 inches long, 2ft 8 inches wide and 1 ft. 10 inches in thickness) have been prepared in this press.

The maximum content of pressed or baled fibre is about 320 lbs.

ERRATUM:

Attention is drawn to an error occurring in the article on Local Land Tenure by Inche Mohamed Noor which appeared in the January number of the Malayan Agricultural Journal. On page 15 under "Premium and Rent in the Federated Malay States" the writer states that no premium is payable in Pahang on Agricultural Lands exceeding ten acres in area; this statement is erroneous, as since June 1920 premium has been payable on such lands in Pahang, where the terms relating to land, (including rent) have been brought into uniformity with those obtaining in the three other States. (Vide Gazette Notification No. 2287/20.)

THE CINCHONA (QUININE) INDUSTRY IN JAVA.

By W. N. Sands.

IN January of the present year, the writer, acting under instructions received from the Acting Director of Agriculture, F.M.S. & S.S., visited the chief districts in Java where Cinchona is sucessfully cultivated in order to obtain as much information as possible concerning the industry as carried on there. The following account is the outcome of that mission.

The history of the introduction into Java from the South American Andes of the different species of Cinchona which produce the barks used in the preparation of quinine, and allied alkaloids, is fairly generally known and need not be referred to in detail here. Briefly, it may be stated that the first attempts at Cinchona cultivation in Java were made in 1852, but these were not a commercial success because the species grown gave such a low yield of alkaloids. In 1865, however, the industry was established on a firm basis following the introduction of seed of a variety of Cinchona very rich in quinine, which was secured in South America by an Englishman named Charles Ledger and known under the name of *C. Calisaya, var: Ledgeriana (Howard), or C. Ledgeriana (Moens).*

The Ledger seed sown in Java yielded 20,000 plants, and it is mainly from these that the remarkable industry has been built up. It may be of interest to add that several survivors of the original Ledger trees are still to be seen in the Government Cinchona Plantations at Tjinjiroean in the Pangalengan district.

As Cinchona cultivation was established in Java as far back as 1865, planters there have available upwards of 50 years of accumulated scientific results and practical experience to guide them in their efforts.

The production of Cinchona bark has become a highly specialized undertaking and the large measure of success which has been attained has led to the capture by Java of the world's market for quinine.

This phenomenal success in due chiefly to: —

(*a*) Excellent agricultural methods.
(*b*) Suitable soil, elevation, temperature and rainfall.
(*c*) A plentiful supply of cheap labour.
(*d*) Careful selection and propagation of desirable strains of Cinchona, more particularly C. Ledgeriana.
(*e*) The regulation in recent years of market prices for the bark by agreements between growers and manufacturers.
(*f*) The valuable experimental and other work, extending over many years, of the Government Cinchona Plantations.

It may be mentioned that recently there has been some restriction of output of bark in order to maintain remunerative prices for quinine sulphate in foreign markets.

ACREAGE PLANTED AND EXPORTS OF QUININE AND BARK.

During the past six years, judging from the large quantities of seed and plants supplied to growers from the Government Plantations and private nurseries, there has undoubtedly been an increase in the area of Cinchona planted, but the acreage now available for new extensions is very limited.

It is difficult, for various reasons, to obtain reliable figures of the total area under Cinchona in the Dutch East Indies, but it is estimated at between 35,000 and 40,000 acres for Java, and 1900 acres for Sumatra.

The exports of Quinine and Bark from the Dutch East Indies for the five years 1916-1920 as given in official reports are as follows:—

EXPORTS OF QUININE SULPHATE.

Year.	Quantity.	Value.
1916	115,175 k.g.	3,800,775 guilders.
1917	120,978 „	6,563,880 „
1918	252,636 „	12,808,517 „
1919	640,328 „	32,336,566 „
1920	118,861 „	not available.

EXPORTS OF BARK.

1916	8,258,474 k.g.	5,533,177 guilders.
1917	2,735,410 „	2,790,119 „
1918	2,439,500 „	2,488,289 „
1919	5,420,796 „	5,529,213 „
1920	4,636,244 „	not available.

The average yearly exports of quinine sulphate for the period named, are 311,395 k.g. (686,042 lbs.) and bark 4,698,091 k.g. (10,350,482 lbs). Taking the average percentage of quinine, calculated as quinine sulphate, in Java barks at 6.25%, the above quantity of bark would yield about 646,905 lbs. of quinine sulphate, which amount if added to 686,042 lbs. of locally manufactured salt, gives an annual production of 1,332,947 lbs. This output is probably in excess of the demand of the world's markets at the present time.

Under an agreement between growers and manufacturers, the latter have contracted to purchase at a minimum price such a quantity of dry bark as will yield 1,134,609 lbs. of quinine sulphate. This amount could be obtained from 18,158,744 lbs. of bark. As the yield per acre of a well-managed plantation in a suitable district is 650 lbs. of dry bark equal to 40 lbs. of quinine sulphate, the total acreage required to produce this amount would be 28,365 acres only. Considering that it is estimated that there are well over 35,000 acres

under Cinchona it means that after deducting the output of the few growers not working under agreement with the Dutch manufacturers who are, as mentioned before, restricting their purchases, and estimating that low yields from unfavourably situated cultivations are counterbalanced by high yielding ones, there is a considerable reserve of bark which could be harvested and placed on the market should circumstances warrant such action being taken.

The Java industry, therefore, is in a very strong position, and it is said that the quinine derived from the local bark represents 95% of the world's output.

Nature of Land on which Cinchona is Grown.

Most of the Cinchona plantations are situated on the slopes of the mountains at elevations between 3500 and 6000 feet. Fairly steep as well as gently sloping land is used. In some places the land is almost flat, but for the most part the cultivations are on sloping ground where rain and soil water can readily drain away. The soils are light loams of volcanic origin, usually of good depth, rich in plant food and easily worked.

The best results are obtained on freshly cleared jungle land with its high percentage of organic matter. Here the growth of Cinchona, particularly "Ledgeriana" reaches its maximum development and yields bark with the highest percentage of quinine. It is important to note that there is now available very little jungle land for the growth of "Ledgeriana" seedlings, and these rarely thrive on land previously used. Stony soil is unsatisfactory as it is very troublesome to cultivate and renders harvesting operations difficult. Clay soils are said to be quite unsuited for Cinchona. On poor lands the trees never develop satisfactorily.

The best soil, therefore, is a deep light friable loam rich in organic matter, well drained and with a gravelly or other porous subsoil. A sloping yet sheltered situation is necessary. Exposure to high winds may destroy trees and branches. On the other hand, in very calm and sheltered places diseases of stem and branch may cause more damage than in open situations. Injury due to the frost has also to be guarded against. Low-lying areas in the Pangalengan highlands were seen on which Cinchona had been killed by it. At 5000 to 6000 feet elevation in Java no damage is done by frost on sloping lands although in adjoining depressions frost may frequently be experienced in the dry season.

Cinchona, particularly the high-yielding and valuable "Ledgeriana" type, is most liable to the ill effects of unfavourable soil conditions, yet its range of growth is capable of extension, within limits, by the grafting of strains selected for particular conditions on the "succirubra" species.

The chemical analyses of some of of the best Cinchona soils in Java indicate that they are well supplied with nitrogen and phosphorous, but the writer was surprised to find in an extensive series

of analyses of soils of a large group of estates no mention of potassium, and it may be that lack of available potash is the limiting factor on the poorer or previously cultivated lands, judging from the physiological effects produced. In similar volcanic soils in the West Indies an insufficient supply of potash in the soil led to the dwarfing of cotton plants, the reddening and the premature shedding of their leaves such as was frequently seen in certain Cinchona nurseries and cultivations.

It is difficult to foretell what effect the dissimilar mountain soils of Malaya would have on the growth and yield of the best quinine producing species and varieties, but the formation of observation and selection gardens at suitable elevations would soon solve this problem.

Elevation, Rainfall and Temperature.

Cinchona is chiefly grown in Java at elevations between 3500 and 6000 feet above sea-level. Below and above these altitudes the yields of bark are not good. The most suitable elevation is from 4000 to 5500 feet, the height of the best estates in the Pangalengan highlands.

There are cultivations established as low as 3200 feet where the trees grow rapidly in early years, but they have a short life—about 15 years only, and are more susceptible to disease. At 7000 feet the growth of the trees is slow and yields are low. The effect of elevation on the percentage of quinine in the bark is negligible between 3300 and 6000 feet where other conditions are similar.

With regard to low elevations, the experiments in Malaya with Cinchona at 1500 feet have clearly shown that the bark produced is useless for manufacturing purposes on account of the small quantity of quinine it contains.

A heavy and well-distributed rainfall is required. In the Preanger and Cheribon mountains, where over 90% of the bark is produced, the annual rainfall is from 115 to 210 inches. The wetter period of the year is from November to April, and the drier from June to September. The driest month is August. On a large group of plantations where the mean annual rainfall for the five years, 1916-1920, was 164 inches, the average number of days per annum on which rain was recorded was 209.

It would appear certain that a minimum yearly precipitation of 100 inches is necessary for the best development of the tree, but this must be so evenly spread over the year that no long periods of drought intervene.

As mentioned previously, areas where frost occurs have to be avoided. The day temperatures of the best Cinchona districts range between 54°F and 86°F, and the night temperatures between 46°F and 59°F. The lowest night temperatures are experienced in the drier months of the year.

Species, Varieties and Hybrids Cultivated.

There are many species and varieties of Cinchona, but few are of commercial importance. At the present time most of the bark used for manufacturing purposes is produced by the "Ledgeriana" variety of *Cinchona Calisaya*. "Ledgeriana" strains produce excellent bark with a quinine content higher than any other kind. They thrive best between elevations of 4000 and 5500 feet.

The original Ledger trees showed much variation in growth, bark characters and quinine content even when grown under similar conditions. The variation in quinine content alone is stated to have been from 3% to 13%. Many strains of this variety have been selected for particular purposes or characters, and wide differences are to be seen between the various types.

The points which receive particular consideration in selection work are:—

(*a*) Strong healthy growth; (*b*) erect stem and erect branching habit; (*c*) the size and colour of the leaves; (*d*) thickness of bark, (*e*) quinine content of bark; (*f*) age at which first flowers are formed; (*g*) resistance to pests and diseases.

The growth character is most important for it is found that certain strains which thrive in one locality do not grow satisfactorily in others, the result is, that on estates in different districts quite distinct types suited to local conditions are to be observed.

The stem and branching habit of the several types show wide variation, and unless those with an erect manner of growth are selected, the trees quickly crowd each other and require frequent thinning so that a smaller yield of bark, per unit area is obtained from strains with the spreading habit than from those with erect characters. Strains with reddish leaves of medium size are favoured by planters, still some of those with green leaves are also good bark producers.

As a good yield of bark is of first consideration, strains are selected with thick bark provided that the quinine content is not below the average. Types are found which produce bark with a very high quinine content, but as a rule their vegetative characters are poor.

The age at which a tree flowers is important for early flowering is correlated with loss of vegetative vigour. As the richest bark is produced in 6 to 8 years after planting, trees which flower before reaching the latter age are not selected.

As to the selection of types showing resistance to pests and diseases, strains were seen which were certainly far less damaged by the sucking insect (*Helopeltis Antonii*) than others on the same plantation. In regard to diseases some of the selections were not as

badly attacked by pink-disease (*Corticium Javanicum*) as others, and planters expressed the opinion that the apparent resistance shown by particular strains to the above-named pest and disease was real.

The 'Ledgeriana' types can only be successfully grown on their own roots on virgin land, of which there is a very limited area now available. Practically all the fields when replanted are put under selected 'Ledgeriana' strains grafted on *C. succirubra*, which has a much stronger root-system than 'Ledgeriana' and grows well over a wider range of territory and in poorer soils.

In a few years it may be expected that practically no strains other than selected grafted 'Ledgerianas' will be grown on most of the Cinchona areas. A first generation hybrid between 'Ledgeriana' and 'succirubra' which produced the so-called "hybrid bark" was rather extensively grown at one time but it is rapidly disappearing. This hybrid had vegetative characters more closely resembling *C. succirubra* than *C. Ledgeriana* but was richer in quinine than the former. It was grafted on to *C. succirubra*.

The variability shown in the growth and leaf characters of some of the 'Ledgeriana' selections appear to indicate that they may have been derived from hybrid trees which had been back-crossed with 'Ledgoriana' but as they are propagated by grafting only, they retain the characters for which they were selected.

"*Cinchona succirubra* produces the bark used for pharmaceutical purposes, and is grown on a few small estates where the elevation and land are not as a rule suitable for 'Ledgeriana.' Large estates grow very little of it for this purpose as the preparation of the bark requires expert knowledge and is troublesome and expensive. On all large estates, however, it is extensively used to produce seedlings for grafting purposes only."

Small plots of *C. officinalis* and *C. Pahudiana* were seen but they are not of commercial importance to-day.

It will be seen therefore that only two kinds of Cinchona are being grown extensively in Java and the one of the greatest importance is 'Ledgeriana' from which especially good strains have been isolated.

The Breeding and Propagation of Cinchona.

Several of the best 'Ledgeriana' types now in cultivation had their origin as chance seedlings in plantations, whilst others have been obtained as the result of planting plots of high-yielding trees under isolation conditions in the forest. It is well known that the original 'Ledgeriana' seedlings showed much variation, with the result that their offspring are also variable in character. In no single instance was a plantation of 'Ledgeriana' seedlings seen in which variation was not observable, even when the seedlings had been derived from isolated seed-plots of selected grafted strains, and the seedlings

had been carefully sorted out in the nursery before being taken to the field. The breeding of Cinchona presents special difficulties owing to this, and also to the fact that the genus has dimorphic flowers, that is, some trees produce long-styled flowers only and others short-styled. The long-styled are more numerous. Seed is produced as the result of the natural crossing by insects of long and short-styled flowers. As far as could be ascertained it is not yet definitely known (a) whether there are self-fertile trees, (b) whether long-styled flowers can be fertilized occasionally by pollen from similar flowers on other trees, (c) whether short-styled flowers are sometimes fertile to pollen from similar short styled flowers on other trees. All experiments so far have given negative results. Observations show that in any plantation with either long or short-styled types only, very few seeds are produced, whereas in seed-gardens where the two forms are always planted together, an abundant supply of seed is obtained. To procure seed therefore, and also to obtain new types, isolated plots are formed in clearings in the jungle far removed from plantations.

The small isolated plots contain two specially selected grafted Ledgeriana trees, one with long, and the other with short-styled flowers, but here difficulties arise for the two trees may not flower simultaneously, for example, one of them may flower when 8 years old and the other not until it is 25 years of age or more. Even should they flower in the same year the flowering period may be different. However, records were seen of some of the results obtained from these plots: in one case the two selected parental types had an average quinine content of 10% and were derived from the original 'Ledgeriana' trees which contained from 3 to 13% of quinine. Their progeny had quinine percentages of 7.57 to 13.57% with an average of 10% as against an average of 8% of the original 'Ledgeriana's—a gain therefore of 2%. This work is important even if there is not a large increase in the quinine content of the bark of the trees, and the breeding operations cannot be closely controlled, because there are fewer poor seedlings produced and there is always a chance that as a result of new combinations of characters, types may be found and isolated which will prove of great value.

Bud Variations:—

Bud-variations or mutations are apparently rare, so that the possibility of improvement of stocks by means of these is very small. One was seen at Tjinjiroean which was quite distinct in growth characters from the tree from which it was obtained, but it was not considered of much value.

Observation Gardens:—

On most large estates a field containing a collection of specially selected trees from different districts is maintained in order to obtain information respecting the growth and yield of bark and quinine of each strain under the particular conditions of the estate. Observations on the trees and tests of the bark are made from time to time, and those strains which show promising results are used to supply shoots for the reproduction of the desirable types by grafting.

Seed-Gardens and Seed Production:—

The isolated gardens for the production of large supplies of Ledgeriana seed are also made in the jungle. In these, selected grafted plants, again of long and short-styled forms, are cultivated. On the Government Plantations about 1000 plants are grown in each garden in the proportion of 800 long to 200 short-styled. On a large private estate the proportions are equal. In this way an abundant supply of seed is produced. To obtain 'succirubra' seed a similar practice is followed.

Seed Selection:—

The seed is contained in a small capsule which opens from the base upwards. The capsules ripen in 5 to 6 months after the flowering period. The seed is small, winged, flat and light in weight. 3500 'Ledgeriana' seeds are contained in one gramme. 'Succirubra' seed is rather larger and heavier than 'Ledgeriana.' On estates where the seed-supply is ample, the seed is not mechanically selected so as to remove those that are imperfect, but on the Government Plantations much care is exercised to obtain seed which will give a germination percentage of not less than 90% when sent out to growers.

When ripe the seed-capsules are collected from the trees and carefully air-dried in large muslin bags hung up under shelter. The capsules open when sufficiently dried and the seed falls out. The seed is next separated from the dry parts of the capsule by winnowing and is then subjected to a sorting process to eliminate those seeds that are defective.

This mechanical selection of the seed is done in a dark room in which a large illuminated box with a flat frosted glass lid divided into four sections is placed. The seed is spread out thinly on the glass lid and women separate the good from the imperfect seed by means of a feather. The light transmitted through the glass lid discloses the character of the embryo in the centre of the seed; if it is imperfect, it is semi-transparent and indistinct in outline; if perfect, it is opaque and well defined.

Specially selected and tested seed is sold to planters at rates varying from 4 to 9 dollars per gramme.

Methods of Propagation by means of Seed and Grafting:—

Only two methods of reproducing Cinchona are practised on a large scale, but these are the most difficult of all the operations connected with the industry in that they require much expert care and attention.

The nurseries are, as a rule, placed in new jungle clearings in sheltered positions and near an abundant supply of fresh water.

A very large number of seedlings is required annually, particularly of 'succirubra' which is used so extensively for grafting.

Both for 'Ledgeriana' and 'succirubra' the same method of sowing seed and raising seedlings is employed. All the seed is sown in specially constructed seed-sheds, formed of bamboo poles of which a large supply must be available. Some estates actually plant special areas with bamboos to meet their requirements. The sheds are from 5 to 7 feet high, and of similar width, with a roof shelter of ½, ¾, or full span. The roof is covered with grass, usually dried 'lallang' or similar material. The sides, including the front, are sheltered by moveable bamboo or grass-covered frames which can be arranged and adjusted as circumstances require. The length of the shed may be from 15 to 20 feet or even longer. A trench 2 feet deep and 2½ feet wide is dug along the whole length of the shed at the back in the case of a ½ span roof; and along the centre in ¾ and full span sheds. A space in front, about 18 inches wide in the former case, and the same width both back and front in the latter, is left to allow room for the grower to attend to the seedlings. The trench is filled with fresh jungle mould and lined off with bamboo poles.

The seed is sown thickly on the top of the mould at the rate of 2 to 8 grammes per square yard, 2 to 3 grammes being the usual quantity sown. The sowing rate varies according to the the ideas of the individual planter. When seed is plentiful, and not purchased at a high price, the larger quantity is occasionally sown, but even with expert care and supervision, there is considerable risk of the resulting mass of seedlings being destroyed by pests and diseases. If successful, this method is less expensive for fewer seed-sheds are necessary.

The seed germinates in about 3 weeks from the time it is sown and from then onwards extreme care and watchfulness have to be excercised in the watering, lighting and sheltering of the young plants. If the soil is too wet or there is insufficient diffused light for the seedlings, "damping off" disease often destroys them; if kept too dry or exposed to wind, "red-spider" or "orange mite" may cause much damage to the tender leaves and shoots.

The best months for sowing seed are May and June but sowings are made in other months of the year, for example seed was being put down in January of the present year on two of the estates visited.

If 1300-1500 young plants are obtained from a gramme of seed this is considered a good average.

A seed-bed 19½ by 3¼ feet, was seen on one plantation which had been sown at the high rate of 8 grammes per square yard and from which 60,000 seedlings had already been transplanted and it was still thickly covered with seedlings.

The seedlings often grow unevenly with the result that some may be removed at 5 months from the time of sowing the seed, whilst others in the same bed may not be ready for 12 months.

When the young plants have developed two or three pairs of leaves and are 3 to 4 inches high they are taken out and transplanted into specially prepared nursery-beds. On most of the plantations

the seedlings are placed out in rows 5-6 inches apart and remain in the same beds until planted out in their permanent situations. On other estates the seed-beds are thinned out earlier and the seedlings transplanted at 2 inches apart. When they are 5 to 6 inches high they are transferred to other beds at a distance of 6 inches each way. In the latter method there are two removals instead of one, and more seedlings may be secured from a given quantity of seed, on the other hand, this method requires more nursery space and entails additional expenditure. In both cases the results are satisfactory.

The nursery-beds, which usually measure 4 feet in width are raised about 1 foot from the level of the ground with a space of 2 feet between each, and as indicated above, are composed of fresh jungle mould. The seedlings for these beds are taken out of the seed-sheds without soil around their roots and are not pinched back. In planting them out, a board 4 feet long and 5 or 6 inches broad as the case may be, and notched along one side at every 5 or 6 inches, is used. A small hole is made in the soil with a wooden 'dibber' which fits the semi-circular notches of the board and the seedling is planted in it. By using a board-spacer such as described, the plants are evenly spaced and the number per bed can be readily ascertained. After the beds are planted they are closely covered with a low flat shelter made of bamboo and dried 'lallang' or other suitable material, which is raised on stakes 18 inches high. These shelters are made in sections so that they can be raised and the seedlings watered and weeded from time to time. In one large private nursery the beds were strewn with finely chopped 'lallang' after planting, to retain moisture and prevent the washing away of soil from the plants by heavy rains. Here again, instead of specially made shelters, the seedlings were covered with the leaves of a fern, resembling the bracken (*Pteris aquilina L.*) The leaves were placed in the ground along each side of the beds and bent over the plants. These fern-leaf shelters are inexpensive and are said to give efficient service for 8 months, by which time the seedlings do not need protection.

The seedlings of 'Ledgeriana' are ready for planting out in their permanent positions in 2 to 3 years from the time of sowing the seed. They should then be about 3 feet high. It sometimes happens that under especially good conditions the plants may be strong enough to take up when 2 years old. 'Succirubra' seedlings are usually ready for grafting when 2 years old; they should then have clean straight stems of the thickness of a finger.

The operations connected with the raising of seedlings have been described in some detail because they are most critical. Unless a full supply of healthy plants is raised annually, progress is retarded. When it is considered that the number of plants required to plant up a field of 50 acres only, is not less than 200,000, the importance of efficient nursery work will be realized.

Grafting :—

In grafting 'Ledgeriana' scions on to 'succirubra' stocks care must be taken to obtain shoots for scions with ripened wood of the previous

year, and of course from trees possessing the good characters it is desired to reproduce. The shoots on removal from the parent trees have their leaves cut off and are kept in a fresh condition until required. The 'succirubra' stock is prepared to receive the scion by making a downward cut about 3 inches long on one side of the plant through the bark and slightly into the wood at the base. The lower portion of the cut should be as near the ground as possible. The scion as prepared for insertion is about 1½ inches long and consists of one internode and a half and contains two nodes with buds in a dormant condition. A portion of the base of the scion, 2½ inches long, is sliced off along one side and the lower buds removed. The scion is then fitted carefully under the bark of the stock and tied in tightly by means of a narrow strip of bast-fibre obtained from the "baru" or "waru" (*Hibiscus tiliaceus*). In the process of tying in the scion, the upper part of the tongue of bark of the stock is cut off, leaving about ½ inch of the lower portion. The graft is then covered with grafting-wax softened in a small portable stove. By using the "baru" fibre the necessity for severing the material when the stock and scion have united, such as is the case with "raffia" is avoided for the bast-fibre decays within a short time after it has fulfilled its purpose. A specially trained man can graft 400 plants per day.

The percentage of the grafts which grow is usually over 90. This was frequently seen, and it shows how skilfully the work is performed. After the buds have started to shoot from the scion, the top of the stem of the stock is pruned off. Later on, when the buds have developed well the stem is cut off just above the graft and all shoots which may grow from the 'succirubra' stock below are removed. The 'succirubra' shoots are readily seen on account of the large size of their leaves.

The grafted plants are ready for the field in 8 to 12 months from the time they are grafted. The grafting operations are usually performed in the wetter months of the year.

From the time of sowing the seed of 'succirubra' for stocks, until the 'Ledgerianas' subsequently grafted on them are ready for the field, a period of approximately 3 years is required.

As stated before, nearly all the replanting in Java is being done with grafted 'Ledgerianas' so that it is essential that large supplies of these should be available each year. The magnitude of this work can be judged from the fact that in the present year there were no less than 2,000,000 grafted plants in the Government nurseries at Tjinjiroean and hundreds of thousands were seen in every private nursery.

Preparation of Land and Planting.

In clearing jungle containing heavy timber felling is performed as in Malaya, but the subsequent treatment is quite different. The larger trunks may, or may not, be removed, most of them however are usually taken away on account of the local scarcity of wood for building purposes and for fuel. After the leaves have fallen from

them, the branches, undergrowth, etc., are collected and placed into depressions and piled along the margins of the fields. The large stumps are not removed. Under no circumstances are the clearings burnt over as this is considered a very deleterious practice leading to the destruction of much valuable organic matter which would in time form humus. The finest Cinchona is produced on soils containing up to 18% of this constituent.

The initial cost of clearing the land is, therefore, heavy, but the results which follow justify the expenditure.

The land after it is cleared is deeply 'changkolled' all over to a depth of not less than 1 foot and lined off for terraces by means of a road-tracer. Much care is exercised in forming the terraces, so that in following the contour of the land they are exactly level.

The terraces may be narrow or fairly wide. On very steep hill-sides they may be only three feet wide, on gentle slopes five feet or more. The edge of each terrace is slightly raised to prevent wash. Well terraced land requires little drainage for even on the steepest slopes very little wash occurs notwithstanding that the rainfall is always heavy.

The terrace-system is universally adopted in the Pangalengan highlands and is a feature of Cinchona culture in those areas. The Javanese cooly is an adept at terracing and draining on account of his training in the wonderfully terraced wet-padi 'sawahs.' The cost of preparing land in this way is high, but it is amply repaid owing to the conservation of the rich surface soil. A few drains are necessary to carry off flood-water but not many of these are required as the rain is evenly distributed over the land and the soil and sub-soil are porus. In the Cheribon mountains, terracing is not done but other precautions, which will be described later, are taken to prevent loss of the top soil.

In preparing land that has already borne one or two crops, a similar procedure is followed, and as much as possible of the organic matter from the *Lantana*, *Eupatorium* and other weeds with which the land becomes densely covered when rested for 10 to 15 years, is buried under the soil. If leguminous green-dressing plants have been grown these are similarly treated.

Fields previously cultivated are sometimes replanted after a brief interval, but this is not usual, and if done, manures—particularly those which contain a fairly high percentage of nitrogen—are used.

The best time for planting is at the commencement of the West Monsoon in October or November; still, it is not always possible to complete the work in these months and the operations may have to be continued till the month of Jannary To ensure success, a sufficient interval before the advent of dry weather must be allowed so that the plants can establish themselves.

The seedlings and grafted plants in the nursery beds are pruned back to a height of about 2 feet, according to the size of the plants and all, or the greater part of, the leaves are removed. The plants are watered if the soil is dry, then lifted carefully without any soil adhering to their roots and taken in bundles to the field to be planted. Only robust plants, free from disease, and in the case of seedlings those closely resembling the type desired, are selected for planting. The usual planting distances are 4 feet by 4 feet or 3 feet by 4 feet but this spacing cannot be strictly maintained on steep lands. The terraces vary in width according to the original slope of the land and therefore each may carry one, two or even three lines of plants as the case may be. For each acre about 4000 grafted plants or seedlings are necessary as some supplying of "dead holes" is always required.

The total cost of establishing a plantation including nurseries, felling, clearing, cultivation, terracing draining and planting was given as from $75 to $106 per acre for average land, with an additional outlay for maintenance, totalling $45 per acre at the end of 3 years when the first small crop of bark may be harvested.

CULTURAL METHODS.

Soil Aeration: In order that the root-system may develop well two methods of aerating the soil are widely adopted on flat or gently sloping land. The first consists of digging long narrow trenches about 2 feet deep and 1 foot wide between each row of trees, with cross-bars at intervals to prevent the lateral wash. If the narrow trenches are discontinuous, they may each be 15-20 feet long alternating with trenches of similar dimensions in adjoining rows.

The other method is to dig pits 3 feet deep where trees have been uprooted in the process of harvesting the bark. This system is in favour in some districts because less damage is done to the roots of the remainder of the trees.

The trenches and pits, in addition to aerating the soil also prevent erosion.

In weeding, the original trenches and pits are gradually filled with weeds, and when full, are replaced by new ones.

Weeding: –Although the trees quickly shade the ground, weeding is always necessary. The plantations are usually "clean weeded" and "changkolled" at least once a year, but often two or three times. The weeds placed in the pits or trenches add considerably to the organic matter in the soil when they decay.

A monthly system of weeding known as "selective weeding" is often practised. Under this system all the grasses, certain of which are particularly difficult to eradicate, are taken out and the less troublesome weeds are allowed to remain until the fields are "clean weeded."

The cost of weeding varies in different districts. It may average $15 per acre, per annum, over a long period of years. In the early years of cultivation, however, it may cost as much as $25 per acre. These figures are of doubtful value, but are given because the pay of coolies in Java appears to be much the same as in Malaya at the present time.

Manures and Green-Dressings:—

Very little manure is used and that chiefly in fields quickly replanted after a crop has been harvested. The manures favoured are obtained from the local oil mills. They may consist of a mixture of coconut, ground-nut and castor meals, or one kind of meal alone. They are essentially nitrogenous fertilizers containing about 6% of nitrogen with small quantities of other plant foods and are applied to the land at the rate of 250-300 lbs. per acre.

Although extensive use is not yet made of leguminous and other plants to improve the fertility of the soil and to prevent wash, still much interest is being taken in the subject and a large number of experiments with different species is being made throughout the Cinchona districts. The plants are grown chiefly in young and old plantations. In young fields they are planted thickly so as to cover the soil rapidly. In older fields they are grown along the lower edges of terraces, and on land not terraced, in lines at intervals across the slope of the ground. When the trees thickly cover the soil, green-dressing plants do not thrive, therefore it is mainly in the earlier and later stages of a plantation that these are useful.

The leguminous plants which thrive well are: *Lupinus luteus. Crotalaria useramoensis*, *Tephrosia Vogelsi Acacia decurrens* and *Albizzia montana*. Many others are under trial, but the first four mentioned above are the chief ones grown in established plantations, whilst all may be grown as cover-crops on lands being rested. Non-leguminous plants, such as a strong growing *Eupatorium* and *Lantana camara* are also allowed to cover lands thrown out of cultivation. The former is used extensively on one estate in areas carrying old trees, where it is planted in lines 30 to 40 feet apart across the fields to prevent wash and supply organic matter. In fields under cultivation all the green-dressing plants are pruned back at frequent intervals and the prunings allowed to remain on the land to form humus.

METHODS OF HARVESTING BARK:

Quinine and the other alkaloids only occur in the bark of the tree. The bark of commerce is obtained from the stems, branches and roots. The first crop of bark is obtained in 3 to 4 years from the time of planting the trees. In the third year, if the growth has been rapid, the young trees may be pruned to one stem and some of the plants thinned out, but as a rule the harvest starts in the fourth year. Experience is necessary in thinning out a plantation. The first trees to be uprooted are those which are diseased or have grown badly; the next those that crowd each other. Superfluous branches on other

trees are pruned at the same time. In selecting trees for removal, care must be exercised that no spaces are left which are insufficiently covered by branches and foliage. The primary object of thinning and pruning is to allow the remaining trees more room to develop and produce good bark. The number of trees taken out at the first harvest may be few or many. In particularly good fields nearly ¼ of the trees may be dug up. The first crop obtained is small and amounts to 125 to 150 lbs. of dry bark per acre.

The thinning out of trees by uprooting them is continued each year, as well as the pruning of the lower branches of others that need such attention till the number of trees is so reduced that further thinning would be unwise. All the trees are therefore removed in time. The age at which complete removal is desirable depends on several factors, such as elevation, fertility of the soil and the market price for bark, and may vary from 15 to 80 years.

From the commencement of harvesting operations in the third year or fourth year after planting, very little replanting is done in the fields. In the first two or three years a few new plants may be put in to fill up large spaces from which unsatisfactory or diseased trees have been removed, but the earlier system of continuous replanting as thinning progressed is now discarded because it gave unsatisfactory results.

The annual crops of bark gradually get larger but after the fifth year they do not increase very much.

This method of dealing with the trees in order to obtain the 'Ledgeriana' bark used for manufacturing purposes is the only one practised on a large scale to-day. It has supplanted the older systems of 'mossing,' 'scraping,' and 'stumping' so often referred to in publications relating to Cinchona.

Trees whose stems or branches are diseased are cut back to within 4 inches of the ground and new stems are allowed to develop from the stump, but healthy trees are rarely treated in this manner.

In uprooting large trees, the branches are trimmed off first, the stem is next felled and the roots dug out very carefully so as to avoid damaging neighbouring trees.

The stems and branches are cut up into suitable lengths in order to facilitate the barking operations. In the case of grafted trees the stems are separated from the roots by cutting them off just below the point where they are grafted. The roots are freed as much as possible from earth, and if necessary, washed in water before being dealt with. The bark is beaten off the stems, branches and roots in the fields. Wooden mallets are used for this work and it is interesting to note how readily the bark is detached from the wood.

Bone-knives are used to take off portions of bark which cannot be beaten off. Knives made of metal are not used as they are quickly destroyed by the alkaloids.

The bark from the stems and larger branches not less than 2½ inches in diameter, is kept separate from that derived from the roots and smaller branches. In the case of young seedlings and grafts, the stem and root bark are not separated because of the low quinine content of each. With older 'Ledgeriana' trees grafted on to "succirubra," the stem and branch bark is of course kept quite apart from that of the root, as the quinine content of the "succirubra" roots is always low and it is not influenced to any extent by the high-yielding 'Ledgeriana' grafted on to it. Close supervision of the harvesting operations is required in order to avoid mixing the different barks. The bark of twigs is not collected.

The cost of harvesting wet-bark is about ½ cent per pound with an average daily output per harvester of 100 lbs.

The uprooting of *Cinchona succirubra* to obtain the pharmaceutical bark takes place in much the same manner as described above but much more skill and care have to be exercised in removing the bark in lengths of different dimensions and to preserve the exterior layers with the attached lichens. The preparation of this bark is carried on by a few small estates. As the bark is produced mainly for the cinchonidine and other alkoloids it contains, and not quinine, the methods of preparing it need not be given in detail here.

Drying of Bark:

The bark of different grades is taken from the fields to the factory and placed in the sun to dry. The sun-driers consist of long wooden trays 8 feet wide and 1 foot deep, raised off the ground, and so arranged that they can be quickly covered with galvanized iron sheets, or grass-covered frames, when rain is falling and at night. The bark is frequently turned over in the trays during the time it is drying. There are several forms of sun-driers, but the fixed tray system with galvanized iron covers is the one generally adopted.

After drying from 3 to 5 days in the sun, the bark is transferred to the "Sirocco." It then contains about 20% of moisture as against 68 to 70% -the average moisture content of wet-bark as harvested.

The "Sirocco" is usually placed in a large two-storied stone or iron building, divided into two or more sections. One end section contains the "Sirocco" and in the others the dry bark, is milled, packed and stored.

The Davidson Sirocco which is now generally used on large estates, is built entirely of iron. The furnace and heating-chamber are on the ground floor, and the drying-chamber immediately above, on the upper story. The drying section contains a number of movable trays with perforated metal bottoms. The bark is placed in these trays and is dried by means of the hot air which rises from below. The temperature of the drying chamber is carefully controlled. It has been proved that the bark does not deteriorate in quality when allowed to dry in the sun for a few days before completing the drying in the "sirocco" at a temperature which should not exceed 80°C (176°F).

A thermograph is placed in a prominent position in front of the furnace to indicate the temperature of the drying chamber at any moment. A rotating dial shows the temperature at a glance, and it also records the temperatures to which the bark has been subjected throughout the whole period of drying, together with the time and duration of such temperatures.

The finished bark contains from 10 to 12% of moisture after drying from 12 to 24 hours in the "sirocco." The length of time required depends on the quantity of moisture originally contained in the bark.

To prepare the dry bark for the market it is simply crushed to rough powder on the floor by pounding it with heavy wooden poles or in a simple disintegrator, and rammed tightly into sacks, each of which is made to contain 180 to 200 pounds.

The amount of dry bark obtained is 40 to 50% of the original weight of wetbark. Mature bark gives a higher percentage of dry bark than that from young trees.

On one large group of estates the average cost of producing dry-bark is 10 cents per pound.

Labour Force Required.

An effort was made to obtain an idea of the labour force required for a plantation but this was difficult to estimate owing to the different systems of cultivation. If the system is very intensive ½ unit per acre would be necessary. For average conditions ¼ unit per acre should fulfil requirements.

Yield of Bark:

The yield of bark varies considerably but on a well managed plantation with suitable soil and elevation and the use of selected types of trees, the average annual production may be taken as under :—

Year of Production.		Quantity of Dry Bark. per acre.		Quinine as Q. Sulphate. %
1st.	...	125 lbs.	...	5
2nd.	...	250 lbs.	...	6¼
3rd.	...	375 lbs.	...	7
4th.	...	500 lbs.	...	7¼
5th.	...	680 lbs.	...	8

The subsequent annual yields may not increase very much and can be taken at 650 lbs. per acre. The general average yield is smaller than this at the present time especially in places where the strains grown are mixed in character and spaces in fields have been replanted as thinning progressed. A yield of 550 lbs. of dry bark with an average quinine content of 6% may be a fairer estimate, still the fact remains that the substitution of selected high-yielding grafted trees for poor ones is being universally adopted and this must have a beneficial influence on the yield of bark in future.

The quantity of each grade of bark obtained from a plantation varies, but most variation is shown in the quantity of root-bark. From rich well aerated soils the percentage of root-bark obtained from the trees is much higher than from those grown under less favourable conditions.

The following statistics of grades of bark harvested in a large plantation in the Cheribon mountains during the five years 1916-1920 are of interest.

Year.	Grade of Bark.		
	Stem.	Branch.	Root.
	%	%	%
1916	32	60	8
1917	71	23	6
1918	60	28	12
1919	38	38	24
1920	47	42	11

The trees were 'Ledgeriana' seedlings and grafts from 3 to 19 years of age. As all of these fields would be older in 1921, it was expected that the harvest of root bark in that year would amount to 16% of the total, however, the percentage is generally lower here than in the Pangalengan area where it may often amount to 50%.

THE ALKALOIDAL CONTENT OF BARKS.

The alkaloids occur chiefly in the bark of the stem, branches and roots. In the wood and leaves there are traces of them, but none in fruits, seeds or flowers. The alkaloids are quinine, cinchonidine, quinidine, cinchonine and amorphous alkaloids. Barks for the manufacture of quinine sulphate are valued in respect of the percentage of quinine they contain.

The alkaloidal contents of the best natural Calisaya bark marketed about 1865, and typical good quality *C. Calisaya var Ledgeriana* bark sold in Amsterdam in 1914, were according to Howard* as under :—

Alkaloid.	Calisaya (1865.)	Ledgeriana (1914).
	%	%
Quinine	3.615	7. 92
Cinchonidine	0.750	0.105
Quinidine	0.165	0.080
Cinchonine	0.340	0.085
Amorphons Alkd. ...	0.980	0.910
Total ...	5.800	9.100

* Howard, D — Journal Society Chemical Industry, Vol. XXV, No. 3.

These results show the oustanding superiority of the variety 'Ledgeriana' as a source of quinine. *Cinchona succirubra*, the only other species of importance, produces bark with 2 to 5% of quinine, but contains larger quantities of other alkaloids, particularly cinchonidine.

The largest quantity of quinine is found in the outer layers of the living bark under the corky portion. It shows a progressive decrease inwards to the cambium layer. The cork also contains quinine but in smaller proportions to that of the true bark. In old trees half of the bark harvested may consist of cork. The quinine is not evenly distributed in the bark tissues, and the richest bark is that of the stem at a height of 4 to 5 feet from the ground. The quinine content is somewhat less above this height and in the branches. The lower stem bark may contain more quinine than the upper. The root-bark always yields less quinine than stem and branch bark. 'Ledgeriana' trees on their own roots produce much more valuable root bark than those grafted on 'succirubra.' The influence of grafting on the quinine content of 'succirubra' stock, when a high-yielding 'Ledgeriana' is placed on it, appears to be negligible, although the writer was informed on one estate that the 'succirubra' stock gave a higher yield of quinine than normal when a good 'Ledgeriana' was grown on it.

The quinine content, calculated as quinine sulphate, of the grades of bark reaped on a large plantation in 1921 with trees 3 to 19 years old was: -

GRADE.	Quinine as Q. Sulphate. %
Branch	5.93
Stem	6.33
Root	5.07
Mixed	5.34

These results are rather low still they give an indication of the relative richness in quinine of the different classes of bark obtained from 'Ledgeriana'. grafts and seedlings at elevations between 3400 to 4500 feet. In the Pangalengan area a somewhat higher return all round is obtained.

The quality of stem and branch bark depends on the age of the bark and the conditions under which it is grown. The effect of age, elevation and soil has already been referred to, and it may be of interest to add that in places where the stems are densly shaded the bark development is poor, but this condition is quickly improved by thinning out and pruning the trees so as to allow the bark to obtain more light and air. Root-bark is also uneven in quality. As a rule thin roots produce better bark than thick ones, but are difficult to harvest.

In a previous table where yields of bark are discussed, it is shown that the first year's harvest of a plantation with good 'Ledgeriana' types in a suitable district may be expected to yield bark with 5% of quinine rising to 8% in the fifth year. The annual increment of

quinine in the bark is studied closely in the selection and observation gardens, and samples of stem-bark are taken annually from each type grown and analysed. In one garden for example, there was noted a group of grafted trees planted in 1915 all of which were derived from a selected parent tree with bark containing 13.41% of quinine. In 1919 or four years from the date of planting, the bark contained 7.96% quinine and in 1920, 11.75%. The 1921 records were not available but it was expected that further increase in quinine would be shown.

It is a noteworthy feature that the quantity of quinine occurring in the bark is not the same even when the grafted trees are all derived from one parent tree and grown under similar conditions adjoining each other. The differences may amount to 2 or 3% and occasionally more. The variation in the quinine content of the bark of seedlings has already been noted and shown to be due to the heterozygous nature of the parental types.

As far as is yet known, there are no seasonal fluctuations in the quinine content of bark.

Degeneration in Yield of Quinine:—

In certain districts disappointment was expressed at the lower quantities of quinine in the bark when harvested than were expected as the result of planting superior grafted types. The view widely held is that the lower quinine content is due to the replanting of lands that have already borne two or three crops. If this is correct, it would appear that some particular plant food or foods are not available in sufficient amounts in such soils, and that with the application of suitable fertilizers the yield of quinine would improve.

Pests and Diseases.

Some of the pests and diseases of Cinchona have been already referred to, such as those attacking seedlings, viz :—'Pink Disease' and 'Helopeltis.' These are the most prevalent, still there are many others which could be named ; in fact long lists have been published by Dutch scientists. Of other pests the large caterpillar of the Atlas moth (*Attacus Atlas*) and a small species with stinging hairs *Euproctis flexuosa* were frequently seen feeding on the leaves. Diseases of root and stem may also cause damage. On the whole it may be said that with the exception of 'Pink-Disease,' the mites and fungi attacking seedlings and 'Helopeltis,' there are few pests and diseases which cause wide-spread damage to Cinchona where good cultural and sanitary methods are practised, and where the trees are grown at suitable altitudes.

The Marketing of Bark.

The bark as graded is purchased either locally or in European markets on the basis of the quinine it contains calculated as quinine sulphate.

The price is quoted in Dutch cents for 1% quinine sulphate per ½ kilogram of bark—the unit. To arrive at the value of ½ kilogram of bark, the percentage of quinine sulphate shown by analysis is multiplied by the price quoted, which is the unit price. For example, supposing the bark contains 6.25% of quinine sulphate and the unit price is 6, the value of ½ kilogram is 37.50 cts. or per kilogram 75 cts. Again if the unit price is 6, the value of ½ kilogram of quinine sulphate is 100 cents x 6 = fl 6.00 or for 1 kilogram, fl 12.00.

At various times producers of bark in Java have attempted to strengthen their position against the manufacturers who formed a combine to keep down prices for bark, but it was not until 1913 that the growers succeeded in making an agreement with manufacturers and obtaining a guaranteed minimum price for the quinine their bark contained. At the same time the growers agreed not to sell bark to anyone else, whilst the manufacturers accepted obligations for buying a certain maximum quantity only. The first agreement was for five years, and this has since been renewed for a further term with certain further advantages to the growers in the form of a division of the profits made by manufacturers when the sale price of quinine sulphate exceeded a certain figure.

Notwithstanding this agreement, some of the large producers consider that they could obtain better prices if they adopted a process devised locally under which it is possible to extract crude quinine sulphate from wetbark on estates. The process is not believed to be covered by patent rights, and as far as the writer is aware it is not yet being worked, because the manufacturers of quinine compounds are not in favour of it. Still there is no doubt that if it could be successfully employed there would be a large saving in the drying, packing, transport and freight charges, all of which are paid by the growers, The freight and transport charges alone would only be about 7 to 8% of those now paid. The cost of manufacture would be far less than the total of the charges given above, especially if the production of this crude sulphate was carried on along co-operative lines.

The Extraction of Quinine.

The extraction of quinine and other alkaloids is carried on in large factories under chemical supervision. There is one large factory at Bandoeng, in Java and two in Holland. These work in agreement, and are said to control 90% of the Java output of bark.

The general manufacturing methods are fairly well known to chemists, but it is in the separation and purification of the alkaloids on a commercial scale and the preparation of the various products for the market that difficulties arise. Several of the processes are said to be secretly guarded.

If it were possible to arrange for the extraction of quinine sulphate locally at some future date in order to supply the demand, then the size and arrangement of a factory would have to be carefully considered in relation to the area and situation of land selected and alienated for Cinchona.

The Malayan requirements of quinine are approximately 20,000 lbs. per annum. Assuming that a factory was required to extract this quantity annually, the amount of dry bark which would have to be produced is 333,333 lbs, containing 6% of quinine as quinine sulphate. From the data already given it has been shown that a moderate annual production per acre of dry bark may be taken at 550 lbs. from plantations at the fifth year's harvest, or 8 years from the time of planting. Therefore, at 550 lbs. per acre the total acreage necessary at the fifth harvest to produce 333,333 lbs. of dry bark would be 606 acres.

Possibly it would not be found practicable at the outset to plant more than 100 acres per annum, even if the labour was available, on account of the large number of plants that would be required. For 100 acres, 400,000 plants would be wanted. It is not likely therefore that the full crop would be obtained by harvesting in the fourth year from the time planting was commenced and a longer time would have to be allowed to reach the stage at which a sufficient supply of bark would be reaped.

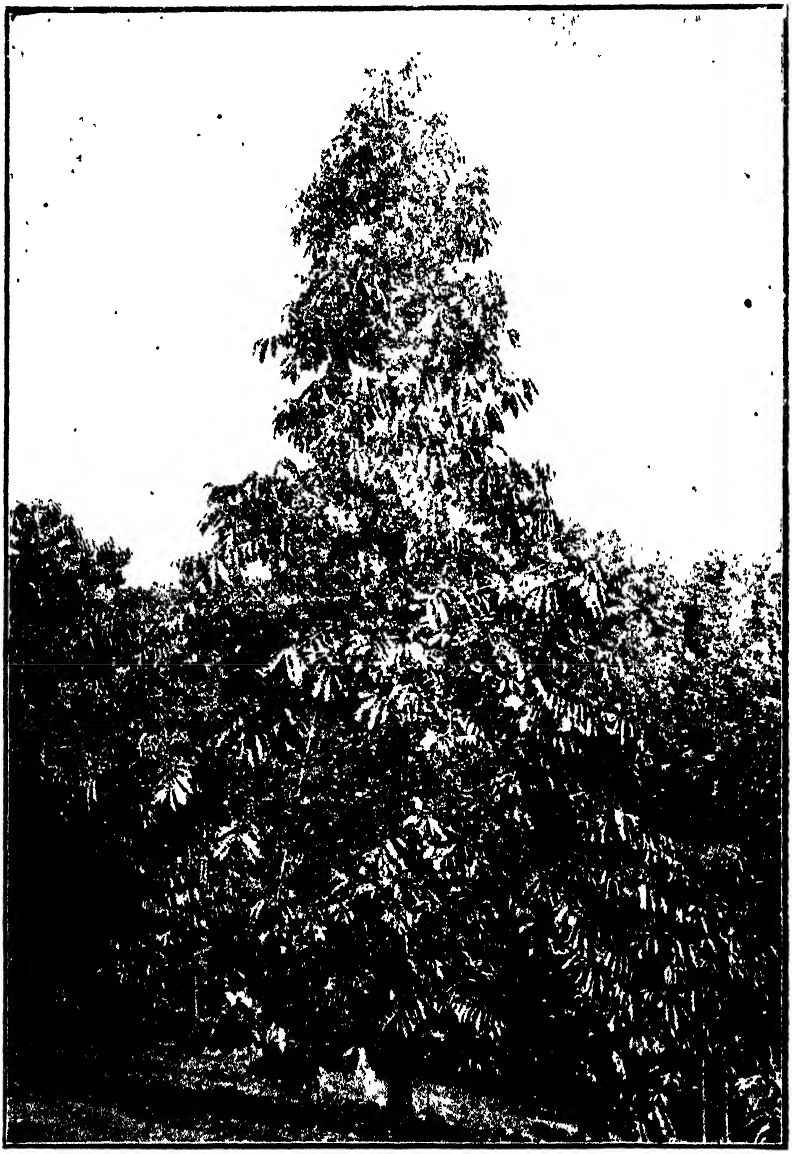
THE POSSIBILITY OF GROWING CINCHONA IN MALAYA.

It is difficult to foretell exactly how Cinchona would thrive under local conditions as so little is known concerning the climate and soils of the higher mountain lands of Malaya, still if areas of land at elevations from 3500 to 6000 feet and not too steep but with good rainfall and fairly light rich soil are found, it may be expected that Cinchona will grow and yield well on them.

The Dutch growers in Java have selected strains of 'Ledgeriana' for dissimilar soil conditions and have extended the culture of these by grafting them on to the hardier "succirubra," so that the establishment of observation gardens for different types of Cinchona at elevations from 4000 to 5000 feet should be undertaken in Malaya at an early date in order that as much information as possible may be obtained concerning the crop, with the least possible delay. Further districts likely to prove suitable for estates should be investigated.

The writer was most courteously received by the Director and other officers of the Department of Agriculture in Java, and every effort was made to supply him with trustworthy information. Also special visits to some of the best privately-owned plantations were arranged. He is deeply indebted to Herr van Roggen, Ag. Director, and Dr. C. Spruit, Botanist of the Government Cinchona Plantations at Tjinjiroean, and the managers of the divisions of those plantations in the Pangalengan district for much valuable assistance; also to Herr C.L.M. Brants of Lodaja and Herr W. Foltz of Wanasari estate.

At Soebang in Cheribon, Mr. E. J. Hammond, Managing Director of the Anglo-Dutch Plantation was most helpful; and a large amount of particularly useful information was obtained here as a result of visits paid to the Company's Tjiater and Panaroeban estates, also Mr. Hammond allowed the writer to peruse interesting reports and obtain statistics concerning Cinchona cultivation in the district.



BRAZIL NUT. *Bertholletia excelsa*

A 10 year old tree at Kuala Lumpur Experimental Plantation

THE BRAZIL NUT IN MALAYA.

By J. N. Milsum.

IN 1912, a consignment of Brazil nuts was received from the Royal Botanic Gardens, Kew, for trial in this country. The seeds were sown in prepared nursery beds at the Kuala Lumpur Experimental Plantation. Good germination was recorded and fifty seedlings were planted out on a sloping piece of land composed of stiff clay loam, with an almost entire absence of humus matter. The land may be compared with the average hilly land of the country, which has proved so suitable for the growth of *Hevea brasiliensis*. A few trees were planted out at the same time in the Public Gardens, Kuala Lumpur, and in other places, and their growth compares favourably with that recorded on the Experimental Plantation.

The trees made good growth but showed no signs of flowering until August 1920, when two of the largest trees, which had been allowed to remain in the nursery beds, produced flowers. These trees were then about 50 feet high, of conical shape, with a spread of 25 to 30 feet, and the lower branches touching the ground. The diameter of the stems was found to be 8 to 10 inches at 3 feet from the base of the trunk. Towards the end of the year, it was observed that a number of fruits had set and in August 1921 they were examined and found to total ten. It was not until November that they were fully ripe and fell from the trees. Meanwhile fresh flowers had been produced and several other trees, that had been transplanted, bore flowers. It would appear, therefore, that the first crop of fruit may be expected when the trees are about ten years old. Four of the fruits that fell were considerably larger than the remainder and weighed over three pounds each, with an average total weight of half a pound of nuts. The smaller fruits weighed about one pound, with an average total weight of four ounces of nuts. The average number of nuts per fruit was found on examination to be sixteen.

Experiments with cuttings and layers have so far been unsuccessful and it is thought that vegetative propagation will not be of service in increasing the stock of this tree. The only method at present is to raise seedlings; the seeds germinate readily if planted in moist, well-drained soil under shade.

Ridley writing in 1909 (1) traces the history of the two large trees in the Singapore Botanic Gardens. These were received from the Royal Gardens, Kew, in the year 1881 and flowered in 1901 for the first time; fruits being produced the following year. Since then a crop has been produced yearly attaining a maximum of over a hundred fruits on the larger tree.

(1) Agricultural Bulletin, S.S. & F.M.S. Vol. IX, No. 12. p. 551.

It would appear that the Brazil nut tree is infrequently planted, the supplies of nuts coming from the forests in the Amazons, where the natives collect the nuts and bring them in for export. Bates records (2) numerous groves of this tree and states that it is one of the loftiest in the forest, towering above its fellows. It seems probable that it may attain a height of nearly 200 feet. Information as to the number of capsules produced by trees in the Amazons is not readily available.

POSSIBILITIES IN MALAYA.

The Brazil nut tree may be considered hardly worth planting as a commercial proposition, taking into consideration the length of time before the tree commences to bear and the comparative smallness of the crop. It is, however, a very desirable tree to plant around the bungalow where space is available, and is an introduction of much value as an additional fruit crop for native 'Kampongs.' The nuts are succulent and nutritious and are likely to be much relished by Malays and other Asiatics in the Peninsula. It is suggested that the Brazil nut tree is an exotic worthy of further consideration and that every effort should be made to establish this valuable tree throughout the Peninsula.

(2) The Naturalist on the Amazons. p. 81.

MARKET PRICE LIST 1ST QUARTER 1922.

Oil Seeds.

	London		New York (In dollars gold.)
Copra ...	£25 £26	per ton ...	
Palm Kernels	£18 £19	,, ,,	
Groundnuts (decorticated)	£20—£22	,, ,, ...	
Groundnuts (undecorticated)	£16—£17	,, ,, ...	
Linseed ...	£17 —£21	,, ,, ...	
Castor Seed ...	£15	,, ,, .	
Gingelly seed ...	£24	,, ,, ..	
Coconut, desiccated (coarse) / Coconut, desiccated (medium) / Coconut, desiccated (fine)	£12 £11	,, ,,	

Oils and Fats

	London		New York (in dollars gold)
Castor Oil ...	£46	per ton ...	$10\frac{1}{2}$—$11\frac{1}{2}$ cts. per lb.
Coconut Oil ...	£39 - £41	,, ,, ...	9 ,, ,,
Cotton seed oil ...	£42	,, ,, ...	7 ,, ,,
Croton Oil		...	$1.10 ,,
Gingelly Oil		...	$1.15 per gallon
Ground nut oil ...	£45	,, ,, ...	8 -18 cts. per lb.
Palm oil ...	£30 £43	,, ,, ...	6—$8\frac{1}{2}$,, ,,
Palm kernel Oil...	£38—£41	,, ,, ...	9 ,, ,,
Tung (China Wood) Oil			13 ,, ,,

Oil Cakes.

Coconut (Poonac)	£10—£13	per ton ...
Castor ...	£6	,, ,, ...
Linseed ...	£15—£16	,, ,, ...
Groundnut (decorticated)	£15	,, ,, ...
Groundnut (undecorticated)	£11	,, ,, ...
Palm Kernel Meal	£5½—£6	,, ,, ...

Essential Oils.

	London			New York (in dollars gold)
Cajeput ...	3/1	- 3/3	per lb.	65—70 cts. per lb.
Camphor (crude)	3/-	--3/4	„ „	
„ (refined)	3/5	--3/8	„ „	87 „ „
Camphor Oil	100/-	—110/-	„ cwt.	20 „ „
Cananga				$3/- 3/10 per lb.
Cinnamon Leaf	7/6	- 8/-	„ lb.	$2/- „ „
Cinnamon heavy			„ „	$11/- —16/-„ „
Citronella Ceylon	2/-		„ „	12 —56 cts. per lb.
Citronella (Java)	3/-		„ „	75—80 „ „ „
Clove	9/-	-10/9	„ „	$2/30 „ „
Lemon Grass	4/		„ „	$1/- —1/20 „ „
Lime Oil (Expressed)			„ „	$2/25 - -2/75 „ „
Lime Oil (Distilled)	2/3		„ „	50 - 55 cts. „ „
Nutmeg			„ „	$1/- --1/15 „ „
Patchouli ...	10/-	-- 12/-	„ „	$10/- — $12/50 per lb.
Ylang Ylang			„ „	
(Manila)	—		„ „	$22/- —$30/- „ „
Vetiver ...	50/-	-	„ „	$5/- „ „

Spices, Drugs, Natural Dyestuffs and Yams.

	London		New York (in dollars gold)
Chillies ...	135/-	- 150/- per cwt	
Cloves (Zanzibar)	1/2	— 1/5 per lb.	31 — 34 cts. per lb.
„ (Penang)		--	48 — 65 „ „ „
Mace			36 -- 38 „ „ „
Nutmeg		—	17 -- 28 „ „ „
Pepper (black) ...	3¾d.	— 4d. per lb.	10 „ „ „
„ (White)...	7d.	-- 8d.	13 — 14 „ „ „
Cocaine			$6/- -- $7/- oz.
(hydrochloride)	10/6 oz.		
Coca (leaves)		—	35 -- 50 cts. per lb.
Cinnamon ...	7½d.	— 1/-	16 -- 19 „ „ „
Turmeric ...	19/-	— 22/- per cwt.	6 — 7 „ „ „
Ipecacuanha ...	5/6	— 6/- per lb.	$1/35 -- $1/75 „ „
Annatto fine		—	27 -- 31 cts. „ „
„ Seed		—	3 — 5 „ „ „
Areca Nut		—	8 „ „ „
Cutch		—	5 „ „ „
Gambier (common)		--	5½ -- 6 „ „ „
„ (cubes)		—	7 -- 8 „ „ „
Papain		--	$2/25 — $2/50 „ „
Patchouli (Leaves)		—	30 — 35 cts. „ „
Vanilla Beans (Mexican)		—	$7/- — $9/- „ „

Fibres.

	London	New York (in dollars gold)
Jute :— Diamonds	£52/- per ton	
Firsts	£38/- ,, ,,	
Lower grades	£31½—£34 ,,	
Bimlipatam	£29	
Hemp, Sisal, Java	£36—£37	
,, ,, Mexican	—	6½ — 7 cts. per lb.
Hemp, Mauritius	£42 — £16 per ton	
,, , New Zealand	£29 — £30 ,, ,,	
,, , Manila	£24 — 42 grades M. to D.	
China Grass (Ramie)	No quotations.	
Kapok Java	10d. — 16d. per lb.	
Ceylon	9d. - 10d. ,, ,,	
Indian	8d. — 10d. ,, ,,	
Akund	6d. — 7d. ,, ,,	

Starches and Sugars

	London	New York (in dollars gold.)
Sago flour	—	3½ — 4 cts. per lb.
Tapioca High Grade	—	4 — 4¾ ,, ,, ,,
,, Medium	—	3 — 4 ,, ,, ,,
,, Low	—	2½ — 3 ,, ,, ,,

Chemicals.

London Prices.

Acetic Acid glacial	—	$9/- — $10/- lb.
,, 80 per cent	—	$8/- $8½ ,,
Ammonia	—	7½ — 9½ lb. (26°)
Acetone	—	8 — 13 cts. per lb.
Calcium Citrate	—	
Citric Acid	—	44 — 47 ,, ,, ,,
Calcium acetate	—	$1/75 per 100 lb.
Creosote	—	40 — 45 cts. per lb.
Formalin	—	9 — 11 ,, ,, ,,
Lime Juice (Raw)	—	
,, (conc)	—	
Sodium Sulphite (Anhydrous)	—	10 cts. per lb.
Sodium bisulphite	—	4½ ,, oz.
Quinine Sulphate		60 cts. per oz.
Wood Alcohol (97%)	—	60 — 63 cts. per gallon

Abstract of Meteorological Readings in the various Districts of Malaya for the month of March, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range	Mean Wet Bulb	Vapour Tension.	Dew Point	Humidity.			
Kelantan, Kota Bahru	...	140.7	81.2	89.93	73.77	16.16	76.5	.820	73.3	77%	...	8.64	1.40
Pahang, Kuala Lipis	...	...	80.62	89.9	71.16	18.75	75.76	...	...	...	...	8.50	1.97
Johore, Johore Bahru	...	...	...	88.21	72.82	...	...	...	...	...	...	14.10	2.49
Singapore, Kandang Kerbau	1014.3	...	80.	84.2	76.9	...	78.6	...	...	...	Calm.	6.23	2.14
Malacca, Durian Daun	1017.8	122.	81.	87.	73.	14.	77.	.893	...	81.	N. W.	5.51	1.73
Negri Sembilan, Seremban	...	150.1	79.5	89.2	72.06	17.14	75.6	.811	72.9	80.8	N. W.	6.04	1.79
,, Kuala Pilah	...	154.5	81.7	89.03	71.3	17.73	77.2	.868	75.7	83.1	...	12.32	2.37
,, Port Dickson	...	153.9	81.9	88.06	76.8	11.26	77.7	.869	75.1	79.2	...	2.38	.59
Selangor, Kuala Lumpur	...	149.9	80.6	88.8	73.8	15.0	76.4	.844	73.7	80.	S. E.	9.55	1.64
,, Klang	...	...	79.8	84.4	74.7	9.7	76.1	...	..	...	...	5.09	.99
,, Kuala Selangor	...	...	...	89.8	70.0	19.8	...	...	...	...	...	5.66	1.59
,, Rawang	...	...	...	90.1	71.7	18.4	...	...	...	...	...	16.14	2.49
Perak, Telok Anson	...	...	81.65	92.	70.	22.	77.06	.868	...	81.	...	12.44	2.12
,, Ipoh	...	...	81.27	96.	71.	25.	76.04	.829	73.79	78.	...	13.89	2.32
,, Taiping	...	...	80.44	93.	70.	23.	77.05	.886	...	87.	...	25.62	4.80
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	20.70	3.50
,, Parit Buntar	...	...	81.95	93.	70.	23.	77.59	.887	...	83.	...	11.73	1.81
Penang, George Town	1008.1	165.	81.4	93.	67.	26.	78.4	.933	70.4	87.3	N. W.	12.79	2.16
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	13.75	3.72
Perlis, Kangar	...	...	..	89.03	72.74	16.29	...	...	...	...	...	12.61	2.35

THE

Malayan Agricultural Journal.

Vol. X. APRIL, 1922. No. 4.

EDITORIAL NOTES.

STAFF.

Capt. J. M. Howlett reported his arrival on 6th April and assumed duties as Agricultural Instructor.

KRIAN PADI EXPERIMENTAL STATION.

The Krian padi Harvest results indicate that the mean yield of one hundred and twenty five lines tested in 1921-1922 season is 15% higher than the mean of native grown padi. The mean of the sixty seven selections for test in the coming season is 20% higher than the mean of this years native crop.

PLANTING MATERIAL.

A large supply of planting material of various fruit trees has now been obtained by the Department of Agriculture, and it is hoped to maintain a stock of seedlings sufficient to meet future demands.

GOVERNMENT PLANTATION, KUALA KANGSAR.

The following is a list of plants under cultivation at the Government Plantation, Kuala Kangsar, Perak.

The Superintendent in Charge will be glad to show any person interested round the Plantation.

Application for "seed" of any of these crops should be addressed to the Agriculturist, F.M.S., Kuala Lumpur.

Roselle Fibre (*Hibiscus Sabdariffa var : Altissima and var : Victor*). Bimlipatam jute (*Hibiscus Cannabinus*). Bengal jute (*Corchorus capsularis*). Kapok (*Eriodendron anfractuosum*). Bowstring Hemp (*Sansevieria sp.*). Sea Island Cotton (*Gossypium barbadense*). Kidney Cotton (*Gossypium brasiliense*). Lima bean (*Phaseolus lunatus*). Ground-nut (*Arachis hypogoea*). Sorghum (*Sorghum vulgare*). Indigo (*Indigofera arrecta*). Tuba Root (*Derris elliptica*). Jerusalem Artichoke (*Helianthus tuberosus*). Tobacco (*Nicotiana Tabacum.*) Gingelly (*Sesamum indicum*).

LOCAL PRODUCTION OF GINGELLY AS A CATCH CROP.

BY J. LAMBOURNE.

THE Gingelly, Sesamum or Teel seed plant (*Sesamum indicum*) known by Tamils as "Ellu" and by Malays as "Lenga" or "Bijan" belongs to the natural order **Pedalineae**. It is an annual herbaceous plant, 2 to 4 feet high, indigenous to Ceylon, South India and Tropical Africa and is cultivated for its seed, which yields from 40% to 50% of oil.

Gingelly is grown chiefly in India, while small quantities are grown in Java, Siam, China, Japan and the Levant. A particularly fine variety of seed comes from Palestine.

The total area of gingelly in India has been estimated at 4½ million acres, yielding 200,000 tons of seed annually. The largest areas are in Madras where over 800,000 acres are cultivated.

MARKET AND USES.

Large quantities of seed are imported into Northern Europe where the oil is used for a large number of purposes, including the manufacture of soap, margarine and other vegetable butters, and also as a substitute for olive oil in salad oils.

Large quantities are extracted in Marseilles, which is one of the principal European ports of import of oil seeds.

In India and Malaya the oil is used largely for culinary purposes and for anointing the body.

SOILS AND CULTIVATION.

In India, Gingelly is grown on a variety of soils, from poor dry soils to the richest delta lands. It is grown as an intermediate crop between padi seasons, when rain falls at a favourable time, and also mixed with cotton, sorghum (*Andropogon Sorghum*) and other crops. There are several varieties of seed, which vary chiefly in colour. The principal varieties are white and black seeds but the colours also range through browns and reds. The white variety is usually grown with cotton, while the black variety is grown with taller crops such as Sorghum.

The most suitable soil for the cultivation of Gingelly appears to be a well drained alluvial loam, but it can be grown successfully on fairly heavy clay soil providing it is well drained and tilled. An experimental crop of Gingelly has recently been grown on the latter

type of soil at Castleton Estate, Telok Anson and, compared with crops obtained elsewhere, the yield was good. The area planted was 2.05 acres.

The plant was grown as a catch crop between coconuts; a good crop of padi had been harvested from this land 6 weeks previous to sowing the gingelly.

The land was prepared by changkolling in the padi stubble, and harrowing after a month. The seed, which was purchased locally and consisted of several varieties, was sown broadcast at the rate of 3 lbs. per acre and harrowed in. The seed was mixed with about twice its volume of dry sand before sowing, to facilitate even distribution and to prevent its being sown too thickly. The seed was sown on 19th and 21st April, 1921 and soon germinated so that by 9th May the seedlings were large enough to be thinned. Thinning and weeding were done at the same time and the plants were left about 1-1½ ft. apart. The area was weeded again on 30th May and 26th June.

Harvesting.

The crop was harvested on 8th and 9th August, 1921. The plants were cut down to within 6 inches of the ground, tied in bundles and taken to a cleared place with a hard floor. The plants were placed in a heap for three days to allow a little heating to take place to facilitate the bursting of the seed capsules; they were then laid out to dry during the day and heaped at night, the seed which had dropped out being collected on each occasion. When the plants were quite dry, the seed was removed readily by beating out the heads.

After the threshing operation the seed was cleaned by being tossed on a rotan tray to remove dust, broken pieces of capsule, etc.; after cleaning, the seed was laid out to dry for a few days and then put up in sacks.

The harvesting, threshing, and cleaning of the crop is very simple and can be carried out without the aid of machinery, although if it were grown on a large scale, threshing and winnowing machines would facilitate cleaning, and probably would be cheaper than hand labour.

Yields.

The total crop of clean seed harvested from 2.05 acres of land was 187 gantangs, equivalent to 1,122 lbs. or 8.42 piculs. As the crop was grown among coconuts, a radius of 3 to 4 ft. must be allowed for each palm and allowance must be made also for drains and boundaries which are included in the area. Allowing 10% for this, the actual area planted with gingelly was 1.85 acres. The yield of seed therefore works out at roughly 100 gantangs per acre, equivalent to 600 lbs. or 4.55 piculs. Comparing this with yields obtained in India, which vary from 850 to 459 lbs. per acre (1) or, what is considered a good crop viz. 500 lbs., (2), the yield obtained is well above the average.

Cost of Cultivation and Harvesting.

The cost of cultivation, harvesting, and cleaning the above crop was as follows :—

		Total.	Per acre.
		$ cts.	$ cts.
Changkolling in Padi stubble	...	13.60	7.35
1 Gantang Gingelly seed	...	1.50	.81
Sowing seeds and harrowing	...	5.20	2.81
Thinning and Weeding ...	...	11.50	6.22
Harvesting ...	...	4.60	2.49
Drying and Threshing ...	...	6.30	3.41
Cleaning	...	4 50	2.43
Total	...	$47.20	$25.52

Value of Seed (Revenue).

The local quotations for fairly clean seed landed in Penang on 20th December, 1921, were as follows :—

Black seed ...	...	$12	per picul
Red seed ...	...	18	,,
White seed ...	...	18	,,
Mixed seed ...	...	11.75	,,

These prices were quoted subject to local handling charges and commission of 5 per cent. on sale value.

A sample of this seed was sent to Penang and $9 per picul was offered, owing to the seed being dusty and mixed. Winnowing was advised in order to obtain a higher price. The seed was however sold locally in Telok Anson for $10 per picul.

Taking the local price of $10 per picul, the profit from one acre, with a crop of 4.55 piculs is as follows :—

Value of 4.55 piculs at $10 ...	...	$45.50
Less cost of production ...	...	25.52
		$19.98

Possibilities of the Crop.

The above profit is not large but, considering that the crop occupies the land for only four months, it is quite satisfactory for a small holder, especially when considered as an intermediate crop between padi seasons. If sown on new clearings among rubber or coconuts, even with a smaller profit than $20 per acre, this crop would assist considerably in paying upkeep costs. It is possible that a better yield could be obtained from new clearings and at considerably less cost, as very little cultivation would be required.

Two crops could probably be taken off a new clearing in a year and would not affect the growth of the permanent crop to any extent, providing space was allowed round each plant for its proper development.

Large quantities of Gingelly oil and seed are imported annually into Malaya and there is no reason why a portion of these requirements should not be grown locally, as the seed could be sold to owners of oil mills in Penang and Singapore and the native oil mills scattered about the country.

Yields of Oil.

By commercial methods of expression the yield of oil from gingelly seed is 32 to 35 per cent. under the system of cold pressure. After the first expression, 5 per cent. of water is added and the mass is again pressed at a temperature of 50°C. A third application of pressure is then made, yielding 10 per cent. of oil in addition to that obtained from the first two pressures. The cold pressed oil, which is the best grade, is clear, pale in colour and has only a faint taste, while that obtained from the second and third pressings is dark in colour, of a decided flavour, with a tendency to become acid. The best grades of oil are used in salads, medicines and for margarine and vegetable butter.

The residue (cake or poonac) is used as a cattle food.

The oil content of the seed varies from 40 to 50 per cent. but it will be seen from the following report by Major C. D. V. Georgi, Assistant Agricultural Chemist, that the locally produced seed was below the average.

"The seed consisted of two or three different coloured varieties, the black predominating."

"The results of analysis were as follows :—

	Per cent.	Per cent on dry material.
Moisture	6.8	
Oil (Petroleum Ether extract)...	10.2	13.1
Residue (by difference) ...	53.0	56.9
	100.0	100.0
Nitrogen	3.2	3.4
Ash	5.6	6.0

"In order to obtain a representative sample of the oil for the determination of the constants, 14 lbs. of the seed were warmed and expressed twice in a small laboratory hand press.

The total weight of oil obtained was 3 lbs. 7 ozs. equivalent to an expression of about 60 per cent. of the original oil content.

The constants for the oil were determined and the results, which are given in the table below, compare favourably with those given by Fryer and Weston "Oils, Fats, and Waxes," Volume I, page 131."

"The oil was light yellow, with only a faint odour; there was practically no deposit on standing."

	SAMPLE	FRYER AND WESTON.
Density at 15.5°C	0.920	0.923
Refractive Index 40°C (ZB) ...	58.5	60.0
Iodine Value (Wijs) ...	108.8	105.0
Saponification Value ...	183.5	192.0
Acidity (as Oleic Acid per cent.)...	2.2	2.5

"*Observations.*—The oil content of the seeds is slightly below the average, 45 to 50 per cent. calculated on the dry seed being the normal amount.

The oil is easy to express and does not appear to develop any large amount of acidity."

Arrangements were also made to express 56 lbs. of the seed in a "Chekku," in order to determine the efficiency of the method and the quality of the oil extracted.

The operation took $2\frac{1}{2}$ hours for two expressions and yielded 21 lbs. of oil and 33 lbs. of poonac or cake, equivalent to 37.5 per cent. of oil and 58.9 per cent. of cake. The remaining 3.6 per cent. was lost in the process of expression.

Samples of this oil and cake were also examined by Major C. D. V. Georgi, who reported as follows :—

"*Oil.*—The oil was clear and bright, yellow in colour, with very small sediment and faint odour.

Only the figure for the acidity was determined, this was found to be 2.9 per cent. calculated as Oleic Acid, being slightly higher than that found for the oil expressed in the laboratory, but not sufficient to affect its quality.

Cake.—The cake when received was very slightly mouldy on the surface but when broken appeared quite fresh inside.
The results of analysis were as follows" :—

	Per cent.	Per cent on dry material.
Moisture	11.2	...
Oil (Petroleum Ether extract) ...	11.6	13.1
Residue (by difference) ...	77.2	86.9
	100.0	100.0
Nitrogen	5.3	6.0

Conclusions.

From the above analyses it will be seen that the oil content of the seed is below the average but the oil is of good quality.

The low oil content is probably due to the fact that the crop had to be harvested before all the seed was thoroughly ripe, owing to its mixed character.

It was however necessary to harvest the crop at the date selected in order to avoid heavy loss from seeds dropping in the field. A certain amount of seed was unavoidably lost, owing to the ripe seed capsules bursting before and during harvest.

The results indicate that this crop is a suitable catch crop on young rubber or coconut estates and that there should be a good local demand for the seed.

References.—1. Agricultural Facts and Figures, Wood.

2. Indian Agriculture, Mukerji.

(Ref. D.A. 1204, 1921).

PRELIMINARY NOTES ON THE RUBBER FLOWER GOEMETRID (HEMITHEA COSTIPUNCTATA, MOORE).

By G. H. Corbett and D. Ponniah.

The habits of the Geometrid moth *Hemithea costipunctata*—have never been previously recorded. Opportunity to study this insect was given in June, 1920, when the Agricultural Department received specimens of the caterpillars.

The manager of an Estate near Teluk Anson in his forwarding letter stated as follows: - "I found the diseased branches and blossoms in my youngest rubber (5 years and 8 months) to-day. It (the disease) apparently only attacks, or only has done so far, the lowest branches starting at the blossom and gradually working down to the branch leaving thereon a blackish discolouration. The leaves curl up, discolour slightly and eventually drop off."

Distribution.

In addition to its occurrence at Teluk Anson, the caterpillars have been found on rubber inflorescenses at the Gardens, Kuala Lumpur, and they are probably present on rubber throughout Malaya.

Extent of Injury

The caterpillars of this moth feed chiefly on the unopened blossoms of the rubber. In captivity, in the absence of unopened flowers, they feed on open flowers. It has not been found possible to rear them on young leaves, but almost full grown caterpillars have occasionally been found feeding slightly on young leaves.

The curling up, slight discolouring and eventual dropping off of the leaves are probably the result of some reaction due to the mechanical injury caused by caterpillars eating the flowers.

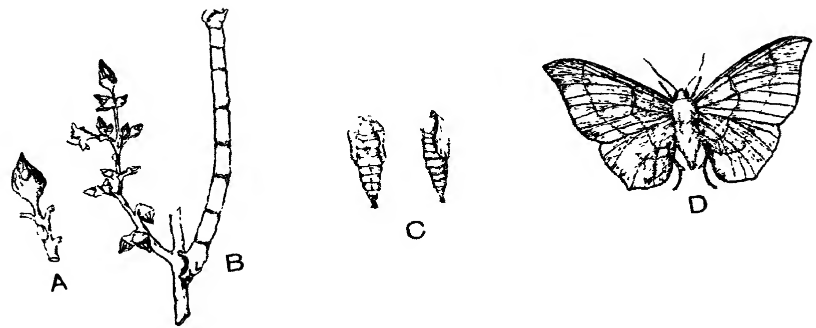
Description and Habits of the Moth.

The description of this moth is given under *Thalera costipuncatata* by Moore in his Lepidoptera of Ceylon as follows:—

"Dull glaucescent—green. Cilia cinereous—white. Wings with a very indistinct transverse discal row of whitish points and a marginal row of white points: forewing with black streaks along the costal edge, and with traces of a whitish inner lunular line. Front of head, palpi, and forelegs above brownish; shaft of antennae and vertex ochreous—white. Expanse 8/10 inch."

The wing expanse of the male is slightly smaller than that of the female.

THE RUBBER FLOWER GEOMETRID



A Eggs on Bud and Stalk of Rubber Flower
B Larva at Rest on Inflorescence Stalk (x 2)
C Pupae (Dorsal and Side Views) (x 2)
D Geometrid Moth (x 2)

The moths are inactive during the day time, and copulation takes place at night.

The female commences to lay eggs four or five days after emergence from the pupa.

The maximum number of eggs laid by one female was 69. These were laid in the course of two days. On the first day 57 and on the second 12 eggs were deposited.

Males and females live for about one week after emerging from the pupae.

DESCRIPTION OF THE EGG.

The egg is flat and cylindrical in shape, shiny and light green in colour, about .35 mm in diameter and .2 mm in height. The upper surface is finely pitted.

The eggs are laid by the female moth on the unopened blossoms and flower stalks of the inflorescence of rubber, usually singly but occasionally in twos and threes, one egg being deposited above the other.

The following table gives the length of time taken for the incubation of the egg.

TABLE I.—*Incubation of the Egg.*

Date eggs laid.	Date eggs hatched.	Number of eggs.	Number of days.	Number of egg days.
1920.	1920.			
8-7	11-7	8	3	24
9-7	12-7	1	3	3
11-7	15-7	2	4	8
9-8	13-8	2	4	8
11-8	13-8	4	2	8
14-8	18-8	1	4	4
16-8	20-8	4	4	16
18-8	21-8	9	3	27
2-11	5-11	18	3	54
2-11	5-11	20	3	60
1921.	1291.			
1-6	3-6	40	2	80
1-6	4-6	22	3	66
1-6	4-6	2	3	6
2-6	5-6	1	3	3
6-6	9-6	1	3	3
6-6	10-6	4	4	16
6-6	10-6	2	4	8
8-6	11-6	39	3	117
8-6	12-6	29	4	116
11-6	14-6	4	3	12
	Total ...	213	...	639

On examination of Table I it will be seen that 213 eggs represent 639 egg days making the average time for the incubation of the egg three days.

The minimum length of time is two days and the maximum four days.

Description and Habits of the Caterpillar.

The larva is at first whitish green in colour with three distinct whitish lines on the dorsal surface running longitudinally throughout the length of the body.

After a few days the colour changes to pink which gives place later to pale green. This is maintained until the larva is full grown.

Prior to pupation the colour is brownish red with indications of dark green.

The body is covered with small hairs.

The head of the larva is light brown in colour with a distinct bifurcation. There are four dorsal projections on the first thoracic segment, the anterior pair are larger than the posterior.

Measurements of ten full grown caterpillars gave 23.9 mm as the average length.

The larvae have three pairs of thoracic legs with only one pair of abdominal feet placed on the ninth segment in addition to the anal pair or claspers. They progress by moving these two pairs of feet up to the thoracic legs so that the body is thrown into a large loop and are hence called "Loopers" or "Geometers."

The caterpillars generally rest during the daytime reposing at an angle from the inflorescence by clasping a pedicel of a flower. In this position they look like the stalk of a rubber flower.

The colour, resembling that of the environment, and the attitude of the larva when at rest prevent it being readily detected and account presumably for this caterpillar not being previously observed.

The length of time taken from the hatching of the egg till the larva pupates is given in the following Table II.

Table II.—*Length of Time of Larval Stage.*

Date Eggs hatched.	Date Larvae pupated.	Larval period in days.
1920.	1920.	
27-9	16-10	19
27-9	18-10	21

Date Eggs hatched.	Date Larvae pupated.	Larval period in days.
1920.	1920.	
27-9	14-10	17
27-9	15-10	18
27-9	14-10	17
5-11	30-11	25
5-11	26-11	21
18-11	5-12	17
18-11	10-12	22
19-11	8-12	19
19-11	8-12	19
1921.	1921.	
26-9	14-10	18
26-9	15-10	19
26-9	16-10	20
26-9	15-10	19
26-9	15-10	19
26-9	17-10	21
26-9	17-10	21
26-9	17-10	21
27-9	15-10	18
27-9	16-10	19
27-9	16-10	19
27-9	17-10	20
27-9	17-10	20
27-9	18-10	21

Twenty five caterpillars were separately bred from egg to pupa giving a maximum of 25 days, a minimum of 17 days, and an average of 19.6 days for the larval stage.

The larvae have been collected in the field throughout the year. The irregularity of wintering of individual rubber trees permits of a succession of generations of this insect.

Description and Habits of the Pupa.

The general colour of the pupa is pinkish, greenish in front: thorax and abdomen minutely black speckled.

A day or two before the emergence of the moth, the greenish colour changes to a dark green.

The average length of ten pupae was 10.59 mm. giving a shrinkage of 13.31 mm. in comparison to the average length of the full grown larva.

The pupa under laboratory conditions is often seen among the inflorescence suspended by its anal end to the stalk of the flowers.

The figures in the following table show the length of time the insect is in the pupal condition.

TABLE III.—*Length of time of the Pupal Stage.*

Number of Pupae	Date of Pupation.	Number of moths emerged.	Date.	Pupal Stage in days.	Number of moths emerged.	Date.	Pupal Stage in days.	Number of moths emerged.	Date.	Pupal stage in days.
	1921		1921			1921			1921	
1	21 May	1	29 May	8	...	...	...	...	...	...
2	22 ,,	1	30 ,,	8	1	31 May	9	...	...	...
2	23 ,,	2	31 ,,	8	...	...	...	...	...	...
6	24 ,,	2	31 ,,	7	4	1 June	8	...	...	...
3	25 ,,	3	2 June	8	...	...	...	...	...	...
6	26 ,,	1	2 ,,	7	5	3 June	8	...	...	...
4	27 ,,	3	4 ,,	8	1	5 ,,	9	...	...	...
11	28 ,,	6	5 ,,	8	5	6 ,,	9	...	...	...
8	29 ,,	5	6 ,,	8	3	7 ,,	9	...	...	...
1	30 ,,	1	8 ,,	9	...	...	...	...	...	...
14	31 ,,	3	7 ,,	7	7	8 June	8	4	9 June	9
4	1 June	3	8 ,,	7	1	10 ,,	9	...	...	...
7	2 ,,	2	10 ,,	8	4	11 ,,	9	1	12 June	10
5	3 ,,	2	11 ,,	8	3	12 ,,	9	...	...	...
6	4 ,,	6	13 ,,	9	...	...	...	...	...	...
4	6 ,,	2	14 ,,	8	2	15 June	9	...	...	...
1	14 Oct.	1	24 Oct.	10	...	...	...	...	...	...
1	14 ,,	1	23 ,,	9	...	...	...	...	...	...
1	15 ,,	1	24 ,,	9	...	...	...	...	...	...
1	16 ,,	1	25 ,,	9	...	...	...	...	...	...
1	17 ,,	1	26 ,,	9	...	...	...	...	...	...
1	22 ,,	1	30 ,,	8	...	...	...	...	...	...
1	22 ,,	1	1 Nov.	10	...	...	...	...	...	...
1	24 ,,	1	1 ,,	8	...	...	...	...	...	...
1	24 ,,	1	1 ,,	8	...	...	...	...	...	...
1	27 ,,	1	5 ,,	9	...	...	...	...	...	...
1	27 ,,	1	5 ,,	9	...	...	...	...	...	...
95		...						...		

It will be noticed from the above Table III that out of a total of ninety five pupae, nine adults emerged on the seventh day, forty six on the eighth, thirty-seven on the ninth and three on the tenth.

Synopsis of Life Cycle.

		Minimum	Maximum	Average
Egg Stage	...	2	4	3
Larval Stage	...	17	25	19.6
Pupal Stage	...	7	10	8.3
		26	39	30.9

Parasites.

Caterpillars have been collected parasitised by a small hymenopterous insect and a tachinid fly.

Conclusion.

Whilst Hemithea is of interest from an entomological point of view in so far that nothing was previously known concerning its habits and its presence on rubber had not been detected, it is at present of no serious importance, but if seeds are required commercially for the extraction of oil further observations as to its habits and control will be necessary.

WORK OF THE INSPECTION STAFF.

JANUARY—MARCH, 1922.

By F. W. South.

STAFF

CAPTAIN S. D. TIMSON proceeded to Penang and took up his duties as Assistant Agricultural Inspector, Penang and Province Wellesley.

The Staff of Special Field Officers in Negri Sembilan has now been reduced to three. This number is considered sufficient to supplement the work of the permanent Inspection Staff in the State now that Mouldy Rot disease is more regularly treated and is under better control.

Estate Visits.

During the quarter one hundred and nineteen visits were paid by the Chief Agricultural Inspector and the Assistant Agricultural Inspector to estates in various parts of the Peninsula.

Diseases of Rubber.

Pink Disease: This disease was newly reported from three estates in Perak North, three in Perak South, three in Selangor and four in Johore.

This disease is fairly prevalent on the eastern border of Province Wellesley adjoining Kedah. It is being well treated in the Province, but unfortunately nothing much is being done on the Kedah side of the boundary. Attention has been called to this point in the past. There was one case in the previous quarter at Pokok Manggis on the seaward side of Penang. This was treated and no further cases have been found. The appearance of a solitary case in such a situation is peculiar.

In Perak North attention has been given to one European owned estate on which the disease was being neglected owing to lack of money for disease control. Routine inspection of small holdings for this disease has been maintained.

In Perak South there have been records of small outbreaks in Kinta all of which have received attention. Such reports are gradually becoming more frequent, though the disease is still of little importance in this district. The disease was as usual prevalent in Batang Padang district, but is being kept under control by the efforts of the inspecting officers. There has been a distinct improvement around Tanjong Malim.

In Selangor, probably owing to the wet weather prevailing during the quarter, the disease has spread in Ulu Selangor district in a westerly direction from Batang Berjuntai and south westerly from Kuang and Sungei Buloh towards Kuala Selangor district in an area where there are several young estates with trees, now at the most susceptible age, from 3 to 6 years old. Useful control work has been maintained, however, by all the Special Field Officers. It is worthy of note that the Special Field Officer has been able to establish a co-operative system for treating the disease among small holders at Ulu Yam and Batang Kali. There has been considerable improvement around Bangi in Ulu Langat district and attention can now be turned to other parts of the the district where cases of the disease are found. The disease was treated by officers of the department on 20 holdings in Selangor.

There is nothing but routine work to be recorded concerning this disease in Pahang, Negri Sembilan and Johore. No cases were found in Malacca during the quarter.

Mouldy Rot.—There was a marked reduction in the prevalence of this disease in all districts of Negri Sembilan, partly owing to a spell of dry weather in February, but also to a considerable extent to the extra care and attention now given to the treatment of infected trees on small holdings as a result of the work of the department's officers. Work was done by the department on one holding in Seremban district and on one neglected Chinese holding near Pengkalen Kempas during this quarter. Such action is reported to have a considerable influence on the small holders. There has been no difficulty so far in recovering the cost of this work in Negri Sembilan.

It is worthy of record that isolated cases have been appearing on various portions of an estate in the Coast district though nothing in the nature of an epidemic has been experienced. This appears to be quite unusual, as thorough and efficient treatment has been carried on since the presence of the disease was first confirmed there during the quarter. A further visit to investigate the cause of these sporadic attacks will be made.

It is satisfactory to be able to record that the efforts of the Assistant Agricultural Inspector, Malacca, resulted in the disappearance of Mouldy Rot disease from the infected estate near Alor Gajah, the estate was quite free from it during the quarter, but will be kept under observation in case fresh cases appear in wetter weather. The reappearance of the disease in this way in places that have temporarily become free from it is frequently recorded.

In Johore the disease once more made its appearance on two holdings near Johore Bahru. Unfortunately it has spread to the Batu Pahat district and is common near the Muar boundary. It has not been found on the the South side of the Batu Pahat river yet. Owners of estates and small holdings have been warned to report it at once if found. With the prolonged drought and the active attention of inspecting officers in Muar and Segamat districts, this disease is less frequently met with, but in Panchor district it is still common.

Black Stripe.—This disease was newly reported from 2 estates in Selangor during the quarter. A few other outbreaks are known to have occurred in the State and to have received proper attention. The sale of "Agrisol" at cost price to small holders around Kajang has been continued, but the demand is not so great as it was three months ago, owing to an improvement in the condition of the areas infected.

The condition of the estate at Jelebu referred to in previous reports is now improved. No fresh infections have been recorded.

It is stated that no cases of this disease were reported from Kuantan district this year, although there is usually a considerable amount of it during the monsoon.

Patch Canker. This disease is present on one estate in Perak North on very old trees. For some time past it has received regular routine treatment. One case was reported from an estate in Malacca.

Root Diseases. On one estate in Province Wellesley an area of coconuts was cut out and replanted with rubber, the coconut trunks being buried in situ. The ill results of this practice, to which attention has been called in the *Agricultural Bulletin*, are now evident in the number of rubber trees killed by root diseases or cut out on account of infection. In such a case coconut refuse should not be buried, but should be dried, split and burnt.

There was a virulent outbreak of Fomes and wet rot (*Fomes pseudoferreus*) on one estate and of wet rot on another estate in Negri Sembilan. The Assistant Agricultural Inspector states that the occurrence of wet rot is becoming more general in Negri Sembilan, cases being found on most holdings growing old rubber. The danger of this disease is never realised by the grower, and proper treatment is seldom carried out, except when the consequences of neglect are explained.

Crickets. These insects were again found to be doing some damage to the bark of rubber trees on an estate in Malacca, but after a shower of rain they disappeared.

No other diseases of rubber call for special attention. Routine work to enforce the destruction of decaying rubber stumps, trunks, or large branches has been continued.

Lalang and Blukar.

The coconut holdings at Beserah near Kuantan are reported to be now all cleaned. In Malacca steps are being taken to have holdings cleared when the owners can be found and the work can be done without undue financial hardship. The general policy in regard to untidy holdings remains unchanged, since owners of rubber land still cannot afford to clear their holdings in many cases.

Coconut Pests and Diseases.

Beetles.—The Black beetle (*Oryctes rhinoceros*) is doing much damage to coconut palms in Penang and Province Wellesley where suitable breeding grounds in the form of decaying coconut and other vegetable refuse abound. At present the main work of the inspecting officers is concentrated on the destruction of these breeding places and of the grubs found in them. Every effort is being made to educate the Asiatic small holders to realise the need for destroying all such refuse; at the same time the co-operation of Government Officers and of European land owners and Managers has been obtained in disposing of all such rubbish on land in their charge. In the past the fact that Crown lands and European owned lands have been neglected from the point of view of plant sanitation, especially as regards coconuts, has increased the difficulty of inducing small holders to do the work necessary without compulsion.

The work is being done systematically lot by lot and mukim by mukim and is necessarily slow, but satisfactory progress is being made.

In Perak this work is continued as part of the usual routine. Bagan Datoh district is receiving special attention as beetles are very common there.

In Selangor the condition of the coconut trees in Klang and Kuala Selangor districts has been bad and a cooly has been employed in each district to treat trees on State land and to do work required if owners fail to comply with instructions. The inspecting officers in these districts are concentrating their attention on this matter at present. It is too early to give results yet, but it is expected that an improvement will first be shewn in Kuala Selangor, where a number of breeding grounds has been discovered and destroyed on both sides of the river. In Klang and Port Swettenham, however, the number of actual breeding grounds discovered has been small, and work has consisted mainly of treating attacked trees and destroying potential breeding grounds.

Routine work has been continued steadily in Negri Sembilan, attention being given specially to bullock stables near towns, since these are the principal breeding grounds of black beetles in most parts of the State. The destruction of various breeding grounds at Port Dickson has resulted in a distinct improvement in the trees there.

In Malacca the Assistant Agricultural Inspector reports that there are now very few dead coconut stumps and timbers or decaying palms of Rembia, Kabong and Pinang to be found in the kampongs. The campaign against the beetles has here been successful and produced good results. Grubs of Black Beetle are now difficult to find.

The Hon. the Resident Councillor, Malacca, has given the department useful assistance in this work by requiring each Penghulu to inspect the trees in his mukim periodically and give detailed reports of the existence of dead stumps and timbers to the District Officer who in turn sends them to the Assistant Agricultural Inspector.

Skipper caterpillars.—An outbreak occurred and was reported on one estate in Perak South. The Government Entomologist and the Assistant Agricultural Inspector visited the estate and the Government Entomologist recommended the use of a solution for spraying the trees. The results of its use are not yet known.

Pests of Padi.

Stem Borer.—The Assistant Agricultural Inspector, Perak North, states that this pest can be found wherever padi is grown in Perak. There is little doubt but that it materially reduces the crop throughout, but it is difficult to estimate to what extent. There has been no abnormal increase of the pest resulting in severe damage to the crop in some localities, as was the case last year. In contrast it may be recorded that the Assistant Agricultural Inspector, Penang and Province Wellesley, has not found, or received reports of, serious damage by these pests in Penang or Province Wellesley, though there are probably isolated cases in the south of the Province.

Nephotettix.—"Bena" this pest increased to sufficient numbers in two localities in Perak North to destroy about ¼ acre of padi in each case. Otherwise it did no special damage.

Podops coarctata.—"Bena Kura" or "Kutu Bruang" no reports of damage by this pest have been received. The pest is, however, present in quantity living in padi stubble in bendangs in certain localities in the sub-district of Bruas. It is practically certain that, should there be an insufficiency of water for any length of time during the next padi growing season, considerable damage will be done by this pest in the localities referred to. Improvement in irrigation would appear to be the only practical way of reducing this pest and of keeping it in check. This insect is also recorded on padi stubble in Perak South.

Grasshoppers.—These were plentiful in many places in Penang and Province Wellesley, but did very little damage. They are recorded as doing a considerable amount of damage in one field in Kuantan district, but did not spread. This is probably the same attack as was referred to in my last report.

Rats.—The Assistant Agricultural Inspector, Selangor, reports that a certain amount of interest is being displayed in Kuala Langat and in Kuala Selangor districts in connexion with measures against rats. The value of barium carbonate as a poison, and general information on its use in conjunction with traps, have been communicated to the District Officers, and to a number of Malays.

Water Hyacinth.

At the end of January the Executive Engineer, Krian, sent in a list of bendangs on which Water Hyacinth was present. In every case the owners of the infected bendangs destroyed the plants when asked to do so.

The special gang in Perak North carried out routine work in clearing the pest from water courses in Krian. At the end of the quarter it was engaged on clearing the pest from swamps on either side of the railway line near Alor Pongsu. The wages of the coolies in this gang were reduced from 1st March.

The plant has been removed from the land occupied by Chinese squatters near Telok Anson.

In Selangor instructions were sent to all Inspecting Officers to take steps against this pest. Two places in Kuala Lumpur district were cleaned up, while in the remaining districts, localities where Water Hyacinth is growing were marked down for future action.

OTHER PESTS AND DISEASES.

Die-back of Cloves.—A form of die-back is prevalent in Penang among the groves of cloves dotting the hill sides. The causative agent is at present unknown. Small holders report that the die-back only occurs after the trees have attained a certain age at present not determined. The matter is being investigated and suitable specimens when obtained will be sent to the Mycologist.

Sugar Cane borer.—This is becoming verv common in Negri Sembilan. Its treatment is difficult, especially as it does not appear materially to damage the cane for the purposes for which it is used at present.

Banana Leaf Curler.—This skipper caterpillar was frequently met with in Negri Sembilan, especially on wild bananas. It was also fairly common in Selangor.

Pests on Roselle. —Several cases of mite attack on the leaves of this plant were noticed in Malacca and specimens were sent to the Entomologist. This mite induces curling of the leaves and shoot.

From another estate diseased specimens of Roselle were found to be suffering from eel-worm attacks. These animals killed some plants in the plot on the Experimental Plantation at Serdang.

SOME NOTES ON RUBBER ESTATES OF THE FUTURE.

By Victor Ris.

[The following article is reprinted from the Archief Voor de Rubbercultuur, VI, No. 6, 1922, in the hope of stimulating discussion. It should be borne in mind that the figures are forecasts, based on expected yields from bud-grafted rubber. Time alone will show whether such yields can be obtained and maintained.

Mr. Ris omits any reference to the probable effect on the market of any large increase of production, although this might be disastrous. Recent experience does not suggest that agreement limiting the area of selected rubber to be planted would be readily obtained, while the risk of loss from disease or accident would be increased.

For the present, Malaya has nothing to fear—should the next five years show the possession of bud-grafted rubber to be essential for survival there would be ample time to start planting operations, and in the interim production costs on the existing plantations could be largely reduced by going for maximum production regardless of injury.

The location of new plantations would present difficulties, as it is doubtful whether much of the present area under rubber could safely be replanted without extensive and expensive cultivation, while badly washed slopes would probably be useless.

For the present for the majority of estates in the F.M.S. the soundest policy would appear to be that of "wait and see". —W.N.C.B.]

1. The influence of selection of planting material on the yield of rubber estates.

UNTIL very recently, in fact, almost until the extensive opening up of Rubber lands was discontinued in consequence of the rapidly decreasing price, all Rubber Estates in the East were planted up with more or less unselected seed. No selection on a clear scientific basis had anywhere been adopted, that is to say, nowhere to any appreciable extent.

The result of planting up such large areas with unselected material is now clearly to be seen everywhere and the following figures illustrate what may be considered to hold good for the majority of Estates in the East when their full planted up acreage is considered.

It may be said that 75% of the planted trees yield 40% of the Crop and 25% of the planted trees yield the balance of 60%.

These trees are hereafter referred to as Class A and Class B trees respectively.

Of the total number of planted trees on an Estate 10% may be said to yield 25% of the Crop whilst 1% of the total planted trees yield 5% of the Crop.

Such trees are hereafter referred to as Class C and Class D trees respectively.

Under "Class A" are included many trees which yield no latex or practically none. Under "Class D" are included trees whose records show they yield year after year between 55 and 60 lbs.

On the basis of these figures we can deduce that an average Estate yielding at present 400 lbs per acre per annum could be expected to yield if planted :

with trees described above as		*class "B"*	960 lbs.	per annum
do	do	*class "C"*	1000	do
do	do	*class "D"*	2000	do

The figures further clearly prove what has been already stated above, i. e. that not only has unselected planting material been used for planting up Estates, but that, taken on the average, *poor* planting material has been used and that it is most important that for future plantings the planting material should be most carefully selected on scientific lines.

In the Dutch East Indies this urgent need has been recognised for a good many years and the highly trained staffs of Botanists attached to the Experimental Stations, and I may here especially mention the Research Stations of the AVROS, have been extensively engaged on work connected with the Hevea selection problem.

The results of their Research work so far obtained show :

(*a*) That the greatest success is attained in grafting or budding parts of selected high yielders on to the young root system of ordinary trees, thereby solving the problem of multiplication of high yielders in a short space of time.

The stems developed from such buddings show all the valuable characteristics of the mother tree. Structure of bark, number of latex carrying vessels, etc., in the offspring stem are equal to those in the mother tree. There is therefore every reason to believe that trees so grown will equal, or at any rate approximate, the yield of the mother trees.

In this connection it is interesting to note, as a further proof that the characteristics of the mother tree will be found in the tree grown from buddings, that the offsprings of yellow latex yielding mother trees yield also yellow latex whilst offsprings of white latex yielders yield white latex. As a matter of fact, one can go so far as to say

that if an "eye" of a yellow latex yielder is grafted on to a white latex yielding stem, a tapping cut made at a later date across the grafting point yields in the upper part yellow latex and in the lower portion white latex. This is merely of course mentioned as a side light on the possibilities of grafting.

Grafting has passed out of the experimental stage and it can be adopted with the best results for any new Rubber Clearings. It is a fact that some hundred thousand graftings have already been carried out with complete success and grafting material from highly selected trees is beginning to form an "article of commerce." First class material is now being very eagerly sought for in many quarters. The AVROS Research Station alone supplied to its members in 1921 about 6,000 meters of branch of selected trees. One meter carries about 10 sleeping eyes suitable for budding.

(*b*) The slower process of multiplication of high yielders, *i.e.* the process of generative selection, is also being very carefully gone into and satisfactory results have already been obtained.

After extensive and often pretty costly experiments it has been possible to obtain self pollination on some selected high yielders. In this way it becomes possible to arrive eventually at the isolation of biologically speaking "pure lines," the selection which is considered to be the ideal one.

This selection naturally will take time before full results are obtained, because "pure lines" can only be determined as such after several generations have proved to show constant characteristics, *i.e.* proved that the characteristics are hereditary.

Moreover even if full results are eventually obtained such "pure line" selection and production of "pure line" seed will very probably never yield sufficient seed for planting up large areas.

The limited number of high class pure line seeds will in all probability mostly be used for growing trees to be used for budding material. Budding as mentioned under (*a*) will therefore remain most probably the principal method of multiplication of high yielders in a short space of time.

2. The influence of the selection of soil on the yield of rubber estates.

Until quite recently, it was taken for granted in the Rubber world that *Hevea Brasiliensis* would grow a paying crop almost anywhere in the Tropics. That Hevea can grow anywhere, or at least keep alive anywhere, is proved to be about correct, but the idea that Hevea would yield a paying crop anywhere has been proved to be a fatal mistake.

Such mistakes have been made in every Rubber planting country in the East; any soil from bare sand flats, peat land to abrupt and rocky hill sides, all classes of soil have been planted up.

The range available for comparison so far as yield per planted acre goes is therefore a very wide one and instances of the extent to which the quality of the soil influences the yield per acre are not far to find. They are at hand in every Rubber producing country.

I intend to deal hereafter especially with conditions prevailing in the East Coast of Sumatra, but all that is to be said can be taken as holding good, mutatis mutandis, in other Eastern Rubber producing countries.

The bulk of the Estates are as already stated planted up with unselected seeds originating all from the same sources and the Estates, therefore, from this point of view, can be taken as being built up on parallel lines. The seed factor can thus be eliminated when the yields of different soils are compared, so also can climatic conditions which are excellent from seacoast to the foot of the hills, from South to North.

But the yield per Acre varies from 250 lbs. per acre to 600 lbs. per acre in specially good fields although considerably higher figures are recorded. It is now, I think quite clear that such variations, a full 140% in yield, form the strongest indication, in fact the clearest possible proof, that the quality of the soil is a prominent factor determining (all other conditions being equal) the yield of the Rubber tree.

Eliminating about 80,000 acres planted on East Coast yielding under 300 lbs. per acre the balance can be taken as yielding an average 400 lbs. per acre per year. Now keeping in view that there are large fields capable of yielding 600 lbs (and over) one is forced to conclude that proper selection of soil influences the yield by an increase of 50%. Taking extreme figures in this connection, 250 lbs and 600 lbs, the influence would be by 140%.

3. The Combined Influence of Seed Selection and Soil Selection on the Yield of Rubber Estates.

Under heading (1) I have said that:

an acre planted with class "b" trees would yield			960 lbs
do.	class "c"	do.	1000 ,,
do.	class "d"	do.	2000 ,,
on average soil yielding from unselected seeds			300 ,,

Under heading (2) I explained that by soil selection the yield can be improved by 50% as compared with the yield of existing average Estates. Therefore:

One acre class "b" trees planted on selected land can be expected to yield 1440 lbs.

One acre class "c"	do	do	1500 ,,
One acre class "d"	do	do.	3000 ,,

In the light of yields as now obtained on average Rubber Estates these figures seem extraordinary, but in my opinion one must look at same as possible figures, certainly so, as far as the intrinsic yielding capacity of selected fields is concerned. The first two mentioned should be obtainable under reasonably careful selection of both factors, seed and soil, whilst the third should be obtainable under exceptionally favourable circumstances and is therefore more of theoretical interest only.

Still, personally, I should not venture to estimate for such yields in respect of any larger Rubber areas to be opened up in future notwithstanding that I am fully convinced that Rubber Estates can be laid out and show an intrinsic yielding capacity as stated for class "b" and class "c" trees.

But intrinsic yielding capacity and actually obtainable yields are two different matters. A number of factors such as for instance the necessity to rest a number of trees from time to time, the influence of the tapping system and tapping force on the yield, are factors which in practice must tend to keep the actual yield well below the maximum the trees are theoretically able to give.

As regards "resting" nothing at this juncture can be said for certain, but from past experience one can deduce the trees benefit greatly by being rested from time to time for shorter or longer periods.

As regards "tapping system" the final word has certainly not yet been said, but in all probability any new system for extracting latex from the trees will always be a system by which not the last drop of latex will or can be extracted and by which the cambium will not be overirritated. Past experience with drastic systems, the cause of Brown Bast and all the misery connected with such, have served as a good lesson.

So far as the influence of the factor "tapping force" goes everyone knows that in the way the tapping force must be used at present, little chance is given the individual tree to yield its best. Improvements as compared with present day methods will certainly be effected in the future but the actual results obtained by any large force, even the best, will always remain below estimated possible results. No large force will ever consist of ideal tappers only, one will always have to be content with average skill.

How these factors and perhaps many others, will affect the actual yield if such is compared with the intrinsic yielding capacity, is difficult to ascertain at this juncture. A number of those who apparently forget to take the adverse factors into their calculations estimate future yields to reach 1500, 2000 and more lbs. per acre and others who are more conversant with the practical, daily working of Estates do not hesitate to estimate for at least 1,200 lbs. In my opinion the latter will be nearer reality than the former.

For the purpose of the following calculation I take a yield of 1,000 lbs. per acre per annum and in doing so, I am sure, I am on the

safe side. (Selection influenced the yield of sugar cane and cinchona by almost tripling the output as compared with former unselected cultivations).

4. Calculation of cost per lb. of rubber for Estates in full bearing of 2,000 acres yielding 2,000,000 lbs. per annum.

It can now be safely stated that Estates producing 400 lbs. per Acre under no restriction scheme can place their rubber on the London market at an "all in cost" of 40 cents. or say 8d per lb. Of that sum 26 cents. represents "Estates Cost" and 14 cents. the cost from f.o.b. to "Sold London."

The "all in cost" per lb. for producers of 1,000 lbs. per acre would fall to about 25 cents. or approximately 5d. per lb. "all in."

The annual net returns per acre from Estates yielding 400 lbs. and 1,000 lbs. respectively therefore compare as follows:

Selling price per lb.	Net return per acre yielding 400 lbs.	Net return per acre yielding 1,000 lbs.
5 d.	loss £. 5.—-. -	£. —.—.—
6 d.	loss 3. 6. 8	profit 4. 3. 4
7 d.	loss 1.13. 4	do. 8. 6. 8
8 d.	- -. -.	do. 12.10. 0
9 d.	profit 1.13. 4	do. 16.13. 4
10 d.	do. 3. 6. 8	do. 20.16. 8
11 d.	do. 5. 0. 0	do. 25. -. -
12 d.	do. 6.13. 4	do. 29. 3. 4

The uncertain factors of Governments income taxes is of course left out of account.

The actual capital cost per acre of the existing 400 lbs. yielders can probably be taken as falling between £50. —and £60.—whilst the cost of the 1000 lbs. yielders to be opened up in future may be taken as lying between £70. and £80.

Considering the possibilities and merits of stringent selection of planting material and soil to be planted up, one is perhaps doing well to bear in mind the excellent results obtained in the Dutch East Indies during the latter half of the last century in the cultivation of the sugar cane, cinchona and tobacco and to remember that no other Eastern Tropical colonies can compete successfully with the Dutch East Indies on the world's market in these lines.

Medan, January 1922.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of April, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun	Temperature. Mean Dry Bulb.	Temperature. Maximum	Temperature. Minimum	Temperature. Range	Hygrometer. Mean Wet Bulb	Hygrometer. Vapour Tension.	Hygrometer. Dew Point	Hygrometer. Humidity	Prevailing Direction of Winds.	Total Rainfall	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	146.33	81.1	88.66	74.30	14.36	76.5	.823	73.4	77%	...	33.77	6.64
Pahang, Kuala Lipis	...	...	80.8	89.7	72.3	17.4	76.7	...	...	...	...	10.80	2.36
Johore, Johore Bahru	...	...	...	89.88	73.83	...	...	..	...	...	...	8.08	1.37
Singapore, Kandang Kerbau	1013.5	...	82.6	82.1	78.4	...	77.5	.921	...	...	Calm.	6.63	1.96
Malacca, Durian Daun	1017.6	127.	82.	89.	75.	14.	79.	.936	...	84.	N. W.	9.01	2.32
Negri Sembilan, Seremban	...	154.2	81.5	89.8	74.1	15.7	73.7	.782	71.9	72.9	N. W.	7.08	1.49
„ Kuala Pilah	...	153.6	82.7	90.3	72.6	17.7	78.9	.911	76.2	78.6	...	4.46	1.22
„ Port Dickson	...	158.5	83.4	89.7	75.1	14.6	78.7	.882	75.7	77.6	...	6.11	1.20
Selangor, Kuala Lumpur	...	152.6	81.3	90.2	74.6	15.6	77.4	.849	74.3	77.	S. E.	5.39	1.13
„ Klang	...	...	...	86.0	75.2	10.8	79.6	...	.	...	...	8.18	2.50
„ Kuala Selangor	...	...	...	90.2	69.9	20.3	...	...	...	...	...	6.13	2.32
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	1.88	.80
Perak, Telok Anson	...	...	82.25	93.	70.	23.	78.03	.904	...	83.	...	11.61	1.85
„ Ipoh	...	...	82.90	96.	71.	25.	77.40	.867	75.34	77.	...	8.46	1.10
„ Taiping	...	...	83.1	95.	72.	22.	77.95	.889	...	79.	...	5.47	3.34
„ The Cottage	...	...	...	...	...	...	..	...	...	...	...	26.88	3.97
„ Parit Buntar	...	...	83.56	93.	71.	23.	78.74	.917	...	81.	...	10.66	2.59
Penang, George Town	1008.6	185.	81.4	93.	67.	26.	79.5	...	72.6	87.4	N. W.	.08	.01
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	13.75	3.72
Perlis, Kangar	...	...	..	90.63	74.10	16.53	...	...	...	...	...	5.39	1.29

THE

Malayan Agricultural Journal.

Vol. X. MAY, 1922. No. 5.

EDITORIAL.

ROOT DISEASES AND THINNING-OUT.

When undertaking a thinning-out programme on Malayan plantations, and especially so when such plantations are more than ten years of age, root disease becomes a matter of primary importance.

In all cases of careful examination carried out on local estates by this Department it has been found that the actual number of trees suffering from root diseases is considerably greater than would be suspected as a result of a superficial examination.

Considerable attention is being paid to the relative advantages to be obtained from a selective thinning-out of existing plantations and from the laying out of new plantations planted with budded stock from known high yielders.

The root disease problem makes contact at this point with these developments. It is a well-known fact that trees suffering from root diseases, *i.e.* White Ants and fungus attacks, are usually high yielders, and a careful examination of the roots of high yielding trees is absolutely necessary before using such trees as a source of bud-wood for vegetative propagation.

An endeavour will be made to show that, in Malaya, the available evidence is in favour of careful selection by thinning-out. There is little or no positive evidence regarding the yields to be expected from budded stock, and this must be left to the future. Even in this latter case the question of disease, in the form of Brown Bast, entering as a limiting factor in the question of yields per acre, has to be carefully considered; this is by far the most important aspect of the Brown Bast problem, and a considerable amount of experimental evidence is in hand to be published at a future date, supporting this contention.

The crux of the thinning-out problem is the response in increased latex yield, made by the remaining trees, to increase of space in which to carry out their normal functions. If satisfactory yields can be maintained or increased over a long period of years by a carefully considered thinning-out programme, it would be extremely

unwise to adopt other methods until such have passed beyond the experimental stage. Our experience has been that, given due regard and care in the early stages of the plantation, a satisfactory yield will be obtained and can be maintained or increased by careful thinning-out, without the risks of disease which would have to be met in any area planted widely originally.

The following table showing yields and thinning-out records is instructive (From a 67 acre block of rubber, planted in 1906, which has passed through the exhaustive tapping stage of the boom period; the estate is inland, soil considered of a good type for rubber growing.)

Yields are given for the periods 1st July—30th June—the financial year of the estate.

Year.	Month in which counts were made.	Trees per acre.	Total yield.	Approx. Yield per acre.
	Jan./14	120		
	May/14	62		
1914–15	...	„	16,606 lbs.	250 lbs.
1915–16	Sep./15	58	18,595 „	280
1916–17	...	„	21,203 „	320
1917–18	Oct./17	55	19,731 „	300
1918–19	May/19	42	17,467 „	260
1919–20	...	„	22,284 „	330
1920–21	...	„	22,329 „	350
1921–22	June/22	41	25,837 „	390
1922–23	...	31	*33,500 (estimated.)*	*475–500 (estimated.)*

The records show a decrease from 120 eight—nine year old trees in 1914 to 41 sixteen—seventeen year old trees per acre at the present date. The thinning-out during 1917-19 from 55 to 42 trees per acre was done by first taking out alternate rows of eleven—twelve year old trees. The trees were left lying and fired in situ; the fire did such grave injury to the remaining trees that the advisability of clearing and replanting the whole area was under consideration. Fortunately this plan was not adopted. After clearing up the place, large numbers of trees with roots attacked by root diseases were unexpectedly found, chiefly a form of Brown Root disease which was entirely subterranean and could not be detected without digging well below the surface. These diseased trees were generally noticeable for their good yields but, in order to obtain a healthy stand and reduce to a minimum, the chance of losing further trees by disease, the roots of each tree were carefully examined by opening up the soil 8 feet around the tree to a depth of 18 inches. As a result the stand was finally reduced to 41 trees per acre.

The yield records require a few remarks. The yield for 1918-19 was low because during this period tapping was stopped for 1½ months. The tapping system from 1914—20th September 1919 was a quarter cut daily. From 20th September 1919 forward the tapping has been done on a single V alternate day.

During 1919-20, a policy of 50% restriction was inaugurated, but later the restriction was reduced to 25%. The manager's estimate for the ensuing year with 25% restriction is 475 lbs.—500 lbs. per acre; during the last two months the yields have been well over the 500 lbs. mark.

This estimate for 1922-23 may be considered on the optimistic side, but the previous records clearly show increasing yields and with a large reduction in the number of trees per acre, there will be a corresponding reduction in costs. Though the estimated yields may not be obtained there is every indication that there will be a very substantial increase next year. The above records can be supported from many quarters. The following extract is from a report sent in recently from an estate in Pahang, on which the manager has carried out extensive yield determinations:—"Strikingly different figures have been registered from trees similar in age, size and general conditions, and these go to prove the absolute necessity of such a test before finally thinning-out mature areas of rubber. It will be at once realised that an estate yielding 400 lbs. per acre per annum is a sounder proposition than one with twice the number of trees and the same yield." "Some estates have gone so far as to cut out old rubber and replant with budded stock, holding that it is better to start afresh with known producers. Such action is unbusinesslike and unnecessary for there are good producers in plenty on most estates."

As careful and more extensive data are obtained, it becomes increasingly evident that the wisest policy to pursue is to work along the lines here indicated until such time as increased yields resulting from vegetative methods of propagation have been well proven. This waiting policy will not leave Malaya behind her competitors. Attention directed towards reducing costs of production of present supplies instead of increasing yields per acre will probably be more profitable in the long run. At least, it can be stated very definitely that little evidence has been collected, and less published, towards establishing the superiority as regards yields of trees planted from budded stock. Further, it is not unlikely that any considerable increase in yield of *Hevea brasiliensis* will result in new problems appearing which, until settled, will leave the rubber industry in much the same position as it now is.

A waiting policy is advisable but at the same time work on budded stock should be carried on in this country and results carefully checked, and compared with those in other rubber-growing countries. There is no doubt however, that a carefully checked thinning-out programme would improve the position of most Malayan estates; yields could be kept up to standard even if no increase took place, and the reduction in cost per lb. would be substantial.

SELECTION OF COCONUTS.

By H. W. Jack.

THE days when rubber estates paid big dividends being now in the past, the thoughts of Agriculturists have turned to crops other than rubber, and coconuts, already well established in the country, are gaining more attention than heretofore. Coconut oil and vegetable oils in general, have sprung to a position of considerable importance in the world's economy during the last decade and the position has been decidedly enhanced since the war which, more than any other factor, proved the utility of vegetable oils.

The following figures clearly indicate the growth of the coconut industry in the Federated Malay States and similar increases occur in the Straits Settlements:

Copra Exports in the Federated Malay States.

					Total Value in dollars.
1904	...	16,404	piculs.	...	—
1905	...	30,172	,,	...	—
1906	...	38,772	,,	...	—
1907	...	19,826	,,	...	452,270
1908	...	71,981	,,	...	162,870
1909	...	106,4[illegible]	,,	...	726,884
1910	...	125,770	,,	...	1,194,226
1911	...	135,064	,,	...	1,294,301
1912	...	129,531	,,	...	1,308,169
1913	...	156,033	,,	...	1,808,913
1914	...	243,754	,,	...	2,174,990
1915	...	231,150	,,	...	1,838,508
1916	...	249,038	,,	...	2,141,739
1917	...	353,722	,,	...	2,505,129
1918	...	428,226	,,	...	3,053,325
1919	...	447,717	,,	...	5,146,575
1920	...	419,988	,,	...	9,216,586

The Officers of the Department of Agriculture have for many years recognised the importance of this crop which has always maintained a foremost place on their programme of work, more especially from the point of view of control of pests. The first enactment in any country which was passed to enforce coconut pest destruction was that of 1890 when the Government of the Straits Settlements gave powers to various authorised persons to order the destruction of pests and their breeding places. This enactment was followed in 1898 by a similar one in the Federated Malay States, and a special staff was organised to carry on a systematic campaign against the various pests of coconut trees. This campaign was eminently successful and saved the industry at a critical time when pests were very much in evidence. The present Inspection Staff continues this good work and has also

been instrumental in instructing all classes of cultivators how to deal most effectively with the various injurious insects.

The problem of the selection of seed coconuts has not been entirely neglected but no scientific breeding experiments have been carried on long enough yet to give definite results, but, experiments have been started in South India, the Philippines, Java and more recently in the Federated Malay States. In Java and the Philippines, selection has been restricted, as far as the writer is aware, to the identification, description and propagation of the best local varieties for special needs. Thus, in the Philippines some twenty-four types of coconuts are described, though only four of them are of considerable commerical importance as copra, toddy, or fibre producers and individual trees showing a notable development of one or other of these characters are selected as seed bearers for propagating the desired features. In the absence of prolonged scientific breeding work, this method of selection if carefully performed should produce good results, but the choice of parent trees is largely speculative for although the characters of the female parent can usually be ascertained yet, because its constitution is unknown, variation in the offspring is likely to occur to some degree in such a method of selection.

In South India work has been in operation for some years for the purpose of producing pure strains of various approved types of coconut for comparative trial as copra producers, etc., but this work is still in its infancy as the first generation of trees from known parentage has not yet reached maturity, as far as the writer is aware.

Some years ago the problem of coconut selection engaged the attention of the Botanical Division of the Federated Malay States' Department of Agriculture, and work, of a preliminary nature, was immediately initiated. Owing to the shortage of staff, scientific breeding experiments had to be postponed until very recently.

The purchase by the Government of Sapintas Estate, gave the Department an opportunity to begin experimental work on coconuts, and some 170 acres on this estate were assigned to spacing, covercrop, manurial and varietal experiments and for selection work. The seednuts for all the areas under spacing, cover-crop, and manurial tests were obtained from one of the oldest and most uniform estates in the country. The collection of seednuts from such a realiable source constitutes the simplest form of selection and is one which should be adopted by every agriculturist in laying out any plantation.

Unfortunately, seednuts so collected are most frequently merely gathered from the piles of nuts accumulated at the store from an ordinary harvest, and nuts thus selected merely provide for the production of trees of average utility. A superficial examination of the individual trees on plantations grown from nuts selected in this manner reveals considerable variation in any character, girth, foliage height, colour, size and shape of fruits, number of nuts per bunch and per tree, length of spathe etc., so that this method of selection cannot be called satisfactory. Should the selection of seed-nuts be done in the

field by marking as parents individual trees which show desirable characters or which closely approximate to an approved type, a much more uniform plantation would be the result. This practice of picking out suitable parent trees does not insure uniformity in a plantation for not only do trees which look very much alike differ constitutionally but seedlings from the same parent tree will be found to vary to an extent, as yet undetermined, on account of cross-pollination which undoubtedly takes place, though not to the exclusion of self-pollination, as contemporaries maintain elsewhere; indeed, "selfing" appears to be the chief natural mode of pollination in Malaya. This has already been proved experimentally in the case of "dwarfs." (Vol. X, No. 1 of this journal).

Coconut trees like all other plants grown as mixed populations show variation in many characters, but the only character of economic importance is that of copra production. The number of nuts which a tree can produce is not a reliable index of its ability as a copra producer because consideration must be given to the size of the nuts, their shape, thickness of meat, etc., which are characters that vary greatly in different trees, but a study of the variation in the number of nuts produced by individual trees affords a glimpse of the extent to which variation occurs. A study of this nature, which has been in progress for a period of twenty-four months, with 453 trees, shows a variation in the number of nuts produced per tree per annum of from 7 to 180. All these trees are about 12 years old and were taken consecutively in blocks of good average coconuts, that is, blocks which averaged upwards of 60 nuts per tree per annum, and the crops produced by each tree were recorded monthly. This study was taken up for the dual purpose of estimating individual tree variation and for selecting good trees as parents of seednuts for planting half-acre test plots, in order eventually to ascertain what percentage of the seednuts will prove true to the parent type and to compare copra yields of the progeny of different parent trees. Preliminary observations seem to indicate that at least 10% of the daughter trees will not come true to type. Similar variation in the amount of copra per nut occurs in comparing nuts from a mixed population, although in choosing nuts from trees of the same variety the variation is greatly reduced. The amount of copra contained in a nut is apparently a distinguishing character between different varieties of coconuts within limits, but young mature trees will yield slightly more copra per nut than old trees of the same variety.

It is a matter of concern with some owners and managers of long established estates that they find that a larger number of nuts is required to produce one pikul of copra than was required several years previously. This is the natural course provided that ordinary cultural methods are maintained and is no cause for alarm, unless the difference becomes extremely great. Mention is made of this matter, because some planters are inclined to select seed-nuts on the basis of the number of nuts required to produce one pikul of copra. This method of selection is erronious because the essential concern on every coconut plantation is the amount of copra which each acre can produce, it matters little whether 200 or 220 nuts are required for the preparation of one pikul of copra as long as the total output per acre

is high. Of course the question of cost of handling nuts must be considered but when differences of only 20 or 30 nuts per pikul are involved, the costs are not materially affected. Sound selection can only be based on the amount of copra produced per tree under estate conditions. For this method of selection it is necessary to study the producing qualities of individual trees and by a process of elimination to ascertain which are the best trees on the estate. This cannot be done in a short time nor can it be done economically over large areas, but the best producing field of each estate should be chosen for selection of seednuts, and a block of, say, 40 acres in that field should have every tree numbered and a record compiled of its yield of nuts per picking. Three one monthly pickings will be sufficient to indicate the poorest trees which can then be dropped out of the experiment, thus reducing the task of record taking by one-third. Records of the number of nuts per picking from the remaining trees should be kept for a further twelve months and then calculations should be made to show which trees produce the most nuts per annum. Having ascertained the best trees from the point of view of number of nuts produced, the next step is to compare the amounts of dry copra produced by the nuts of each tree. For this purpose as many ripe nuts as possible should be taken from each of the best trees, taking care that the nuts from all the trees in the comparison are, as far as can be discerned, equally ripe. The nuts from each tree should be carefully converted into dry copra in separate lots and weighed and then a calculation made of the amount of copra produced per nut from each tree. The best trees having been determined, it is now necessary to examine their individual environments for should any of them occupy especially favourable positions with regards to light, drainage, etc., they should be discarded, because their high productivity, which may, with certainty, be partially ascribed to their favoured situations, might fall very low under normal estate conditions. Finally, only trees which appear healthy in every respect and as nearly the same type as possible should be chosen, and the number selected should depend on the size of nursery required. In a block of 40 acres, say 1,900 trees, it should be possible, under average estate conditions, to find 100 trees capable of producing over 110 nuts per tree per annum, which would be sufficient to supply 900 nuts per month for the nurseries. As already stated, many seednuts so selected will not produce trees true to the parent type, but this method of selection is the only pratical one for the planter to adopt.

The production of pure strains of coconut, which is the only certain method of producing uniform and high yielding estates, lies beyond the power of the planter, because it necessitates initial work stretching over at least three generations of trees, but this work has recently been inaugurated by the Department of Agriculture and will, it is hoped, be continued to a successful issue.

The type of coconut to select for future plantations would appear to be a medium sized rounded nut. Large nuts are generally produced in small numbers and oblong nuts on the average contain less copra per nut than round ones. At the same time, it is quite possible that exceptional trees, which bear large numbers of large nuts, may be found and, if so, they should of course, be selected as parent trees for

some of their offspring are sure to inherit the parental heavy yielding characters. The above remarks refer entirely to tall coconut trees (as opposed to dwarf) but a few words about dwarfs will not be out of place. So far, none of the types of dwarf trees has been encouraged in India, Ceylon or Java, where coconut cultivation has been so long in vogue. In Java the orange type of dwarf is said to be the only one which produces nuts in anything like sufficient numbers to enable it to compare with tall trees as copra producers per acre, taking working costs into consideration, but this assertion needs investigation. The manager of a local estate contends that a certain type of dwarf (niyor gading) is capable of producing far more copra per acre than is produced by average tall trees. He has planted large areas with this type of nut and the development and output of the areas will be watched with considerable interest. Also shipments of these nuts have been sent to Ceylon, Burma, Java, and India for comparative trials in those countries, in which the "niyor gading" may not have been known authoritively, previously. With regard to dwarfs, Copeland, in the Philippines, says "the difference in economy in handling large nuts and small nuts is so great that even though one of the dwarf nuts which, in general, mature several years sooner than the large nuts do, were approximately equally productive with one of the very large varieties it would still in the long run, not be economical to select the dwarf nut for the manufacture of copra." Apparently he has had no experience of dwarf trees which yield more copra than tall trees, but apart from his reason for the discouragement of planting dwarf trees, there are grounds for believing that their life period is limited as compared with tall trees and that their particular advantage lies in the fact that they give a more rapid return on capital expenditure. Of course, as our knowledge of dwarf trees increases, it may be found economical to plant them and when they begin to decline, to cut them out and replant but this largely depends on the yields obtainable from mature trees.

Observations regarding types, growth, pollination, production etc. of dwarf palms are being recorded and will be communicated in the pages of the Malayan Agricultural Journal from time to time.

With regard to the possibility of selecting types of nuts by the quality of oil they contain, experiments by the Chemical Division seem to indicate that the oils contained in different types and varieties of nuts do not vary to any appreciable degree and certainly not to an extent likely to affect the market price of oil derived from different varieties.

Over seventy parent trees have been selected as probable heavy yielders by the Botanical Division, the selection in some cases being based on yield data extending over more than a year, but most of the trees were selected by field examination. A sufficient number of seed-nuts has already been collected from most of these trees to plant up half an acre of each for comparative yield trials of blocks and of individuals on attaining maturity as a basis for seed selection. Many of these lots have already been planted out in the field and care is being taken to give them good average cultural conditions.

In addition to work regarding the selection of heavy yielding strains of coconuts, a study of the different tvpes of coconut grown in Malaya and elsewhere is essential, in order that the experimenter may become expert in picking out and describing the different characters of importance for the accumulation of data which may give clues to correlation and variation factors, and to throw light on the capabilities of different varieties, etc. For a comparative study of this nature, the Botanical Division has collected seed-nuts of eighteen distinct types of coconuts representing local varieties and has imported seed-nuts from most coconut producing countries and planted them in blocks on Sapintas Estate. These importations which should prove interesting in about five years' time include types from Borneo, Java, Ceylon, Seychelles, South India, Cocos Islands, Panama, Burma, Madagascar, etc. The scope of coconut work is wide, and the many problems it presents other than those connected with selection work, are interesting. It is hoped that the gradual development of the Government Experimental Coconut Estate will do much in the next decade to clear up some of the more pressing problems connected with this useful and profitable crop.

OIL EXPELLERS.

By B. J. Eaton.

IN continuation of the information on the Anderson Oil Expeller published in the Agricultural Bulletin Vol. VII (1919) No. 1 pages 9 and 13, the following additional information on Oil Expellers may be of interest.

Anderson Oil Expeller.

The Anderson Oil Expeller is used for expressing copra in Ceylon, and in mills visited by the writer in Colombo in May 1921, satisfactory results were being obtained. The copra was crushed or broken into small pieces and heated in preliminary hot air drying chambers before being treated in the Expellers.

During a recent visit to a large copra oil mill in Singapore the writer also saw a battery of five of these machines in operation for the first pressing of copra and the engineer in charge of the mill expressed his satisfaction with the results obtained. In this mill however copra is normally pressed twice in hydraulic cage presses and the Expellers are now substituted for the hydraulic presses formerly used for first pressing.

These machines, equipped with pulley on side for belt drive, foots elevator, stationary strainer, tempering apparatus and shaker feeder, were quoted at $13,000 (Straits) F. O. B. Singapore in the latter part of 1921.

Motors of 15 and 20 H.P. for driving the Expeller were quoted at $2,700 and $3,000 respectively. If electric current is not available, the Expeller can be driven by other power.

Smulders Oil Expeller.

Automatic Expellers have also been constructed for some years by the firm of Franz Smulders, Utrecht, Holland, who have forwarded details in respect of their machines. This firm states that over 400 of these machines are working in Holland and the East Indies and giving satisfaction.

It is preferable in making enquiries from the firm in respect of the machines to state the type of seed which it is proposed to express and the quantity per unit time with which it is proposed to deal.

The chief advantages of this machine, as in the case of the Anderson Oil Expeller, are low cost, small space occupied, little or no foundations required and few workmen for operation.

The following estimates have been quoted by this firm :—

Distribution heated kettle	...	260 guilders.
Expeller	...	7500 „
Set of spare parts ...	...	850 „
Packing extra ...	...	6 per cent.

The Expeller (Type B) for copra, is supplied with tempering apparatus 12 feet long, working at a maximum steam pressure of 45 lbs. per sq. inch, return conveyer, set of tools for each set of four expellers or less (including ratchet wrench, socket wrench, bar lifter, screw driver and car wrench) and condensing vessels for each expeller.

The set of spare parts includes one quillworm, one threaded spacing collar with bronze ring, one cone point, three discharge worms, three worm spacing collars, half a set of steel bars for press cage, (88 bars) and two anti-turn bars.

Additional plant required :—In addition to the necessary Expellers to deal with the output of a factory, a boiler, engine or motor, crushing rolls and filter press are required, in addition to the necessary belting, piping, storage tanks and container for oil.

(Ref. D. A. 899/21.)

BOTANICAL NOTES ON THE BRAZIL NUT TREE IN MALAYA.

By W. N. Sands.

IN the Garden's Bulletin, Straits Settlements, Vol. II, No. 12 of August 1921, there is published an article by G. B. Deshmukh on the fruiting of the Brazil-nut-tree in the Singapore Gardens. The Singapore plants were introduced from Kew in 1881, and observations were made on these in order to ascertain whether the trees belonged to the species *Bertholletia nobilis* or *Bertholletia excelsa.* After reviewing the literature on the subject, the writer points out that the Singapore trees would fall into the species *Bertholletia nobilis* and not *Bertholletia excelsa* if Young's description of the fruits in the Botanical Gazette was relied on; whereas if Miers' description of these two species of *Bertholletia* in the Transactions of the Linnean Society was followed, certain of the characters would be those of *Bertholletia nobilis*, and others of *Bertholletia excelsa.* The conclusion arrived at, however, is that the Singapore trees belong to one species only.

As mentioned in the article by J. N. Milsum in Vol X No. 3 of the Malayan Agricultural Journal, a consignment of Brazil nuts was received from Kew in 1912, and fifty seedlings were planted out in the Kuala Lumpur Experimental Plantations. The trees have grown particularly well and two of the largest recently flowered and fruited.

As these trees are derived from a much later importation than the Singapore trees referred to above, it may be useful for reference purposes to add notes concerning their vegetative, flowering and fruiting characters.

The vegetative characters of all the trees indicate a common origin and no variation has been observed in them.

Leaves.—10—12 inches long, 3½ to 4½ inches wide, alternate, exstipulate, oblong, pointed, sub-coriaceous, glabrous, shiny dark-green above and dull lighter-green below: rufescent when young; margins minutely serrate; petioles short, ½ to 1 inch long, stout, deeply channelled along the upper surface.

Inflorescence.—Large panicle, 10—14 inches long, chiefly terminal on branches at, or near, the top of the tree. Smaller inflorescences sometimes arising below the chief terminal one. Primary branches 2 to 6, at first horizontal, and then becoming erect. In large panicles a few secondary branches. Flowers opening in centripetal order (racemose).

Bract.—Light-green, cuneate, concave, caducous.

Bracteoles.—2 light-green, concave, half covering young flower-buds, caducous.

Flower.—Large, $1^{1}/_{2}$ inches in diameter, hermaphrodite, peduncle short, stout, $^{1}/_{8}$ inch long.

Sepals 2, epigynous, joined together in young buds but splitting apart as flower expands, tridentate, yellowish-green, tube adnate.

Petals 6, polypetalous, imbricate, unequal, recurved, fleshy at base, creamy-yellow.

Stamens numerous, fertile and sterile. Fertile small, closely packed together forming a corona on a fleshy urn-shaped disc; filaments short, swollen towards apex: anthers lightly attached and dehiscing longitudinally. Disc extended on its lower side into a tongue-shaped body, $^{3}/_{4}$ inch long and $^{3}/_{8}$ inch wide, tinged with magenta on inner surface, and terminated by a large smooth creamy coloured globular mass containing sterile stamens or staminodes. The tongue-shaped extension of the disc with the staminodes is tightly incurved and pressed upwards against the fertile stamens which fit closely into a groove which runs along the upper and inner surface of the globular body. Staminodes shortly stalked, yellow, about $^{1}/_{2}$ inch long. The tongue shaped portion of the disc bearing the staminodes acts as a spring which only a heavy bee such as the Carpenter bee, (*Xylocarpa* sp.) can depress and in so doing gain access to the interior of the flower.

Carpels 4, loculi 4: style longer than fertile stamens, recurved; stigma capitate ovary inferior top slightly depressed with numerous small ridges radiating from the base of style; ovules few in each loculus; placentae axile.

Fruit.—Large spherical pyxidium, about $18^{1}/_{2}$ inches in circumference, and $5^{3}/_{4}$ inches in diameter, rough, surface densely lenticellated: at apex a circular depression about 3 inches in diameter with opercular opening approximately central. Wall of fruit $^{11}/_{16}$ inch thick of which the outer cortical layer is $^{5}/_{16}$ inch and the inner hard woody portion $^{3}/_{8}$ thick; outer layer cracks with age but does not peel off. Opercular opening $^{1}/_{4}$ inch in diameter widening inwards to $1^{1}/_{4}$ inch at base. Operculum large, conical with a short point; attached to columella and eventually falling into the cavity of the fruit. Nuts about 16,* triangular. $2^{1}/_{8}$—$2^{1}/_{2}$ inches long, side $1^{1}/_{8}$—$1^{3}/_{8}$ inches, middle of back, $^{6}/_{8}$ to $1^{1}/_{4}$ inches.

It should be mentioned that the above description of a fruit applies to a typical specimen from one of the trees. Some variation

* The average number of nuts was 16 in the ten fruits examined.

was observed in the size and shape of the fruits from the other tree ; these were smaller and somewhat elongated, the nuts, also, were not as large, but the other botanical characters were similar. Further as previously mentioned no variation could be detected in the trees which have not yet fruited, therefore the writer considers that the Brazil-nut trees growing in the Kuala Lumpur Plantations belong to one species only and until the matter is definitely settled by the Kew authorities this may be either *Bertholletia excelsa*, Humb and Bonpl, or *Bertholletia nobilis*, Miers.

CHEMICAL NOTES.

By B. J. Eaton.

Slab Rubber.

TEN tons of slab rubber which, after maturation, is creped and dried on the estates, is being exported by a well known group of estates in the Federated Malay States. Latex containing over three pounds of dry rubber per gallon is used and the latex coagulated in tanks in pieces of suitable thickness for handling on the crepeing machines by removing every alternate division board in the tanks.

The slabs are matured in smoke houses at ordinary temperature *i.e.* no fires are used in the smoke houses. The resultant crepe is of good even appearance and has a drab colour. The final dried crepe is practically odourless.

An enquiry has been received by another estate for this type of rubber.

Preservation of Latex.

A number of enquiries has been received as to the most suitable method of preservation of latex for shipment to Europe and America. At present the addition of ammonia in the form of Liquor Ammon Fortis (the most concentrated solution of ammonia on the market) is being recommended. Two per cent. of Liquor Ammon Fortis calculated on the volume of latex is recommended or approximately $3\frac{1}{4}$ ozs. per gallon of latex. In order to save freight the latex should be as concentrated as possible and, except on a rainy day, it should be possible to collect and ship latex containing from 2.5 to 3:5 lbs. of dry rubber per gallon.

In considering the prices offered for such latex, sellers or producers should ascertain the dry rubber content required as the price offered should be higher for concentrated latex of a high rubber content.

Experiments are being carried out to ascertain the possibility of substituting preservatives other than ammonia, since this chemical is expensive. The present price in England is about $6\frac{1}{2}$d. per lb. or 4/9 per gallon, so that the quantity recommended would cost about 1d. per gallon of latex. The total cost of ammonia however is considerably higher, as the freight on this chemical is high.

It should also be pointed out that drums of Liquor Ammon Fortis should be handled with great care and the stoppers should be removed in the open. The operator should also be careful not to stand over or hold his face directly over the containers when removing the stoppers. The strong solution is saturated in temperate climates

and is supersaturated in tropical temperatures, so that there is considerable pressure in the bottles and frequently, on removing the stoppers, the whole of the contents may spout as a fountain and blind the operator.

It is possible that steel cylinders of compressed ammonia, which can be imported, may prove more economical than the importation of Liquor Ammon Fortis but the addition of the ammonia gas to latex from such cylinders requires controlling by a skilled operator. Automatic pressure gauges may be purchased in England to deliver the gas at a definite pressure but the quantity released at a definite pressure over a given period would have to be measured by absorption and estimation.

Preserved latex can be shipped in clean sealed kerosene tins, preferably packed two in a wooden case, or in drums.

The use of preservatives or anti-coagulants such as soda or sodium carbonate will depend partly on the use to which the latex is applied and its subsequent treatment. If subsequently coagulated by acidification, an alkali such as sodium hydroxide or carbonate will probably be quite suitable but free alkali in rubber causes deterioration and produces a tacky product.

Desiccated Coconut.

An article containing more details in respect of the machinery and methods employed for the manufacture of desiccated coconut has been prepared for publication and experiments on methods of preparation of desiccated shredded coconut and of other coconut products in sealed tins are being carried out.

It has been found that the dried shredded material cannot be preserved locally in cardboard packets enclosed in tracing cloth and carefully waxed. This means that sealed packets, e.g. lead lined boxes or sealed tins are necessary for export.

It is of interest to note that a factory has already been erected near Butterworth for the manufacture of desiccated coconut.

Nipah Palm.

Tapping experiments on the Nipah palm are being continued but the results obtained are not sufficiently complete or extensive to enable definite recommendations to be made.

It is not possible to ascertain the age of any of the palms, either on indigenous or planted areas.

Two plots, one near the coast and one inland, have been selected for planting and tapping operations, although it will not be possible to tap palms planted from seed till the third or fourth year after planting.

A paper containing the results of available information has been prepared.

Inventions.

New Preparation of Rubber.—A promising invention in connection with a new method of preparation of raw rubber has been patented recently.

This consists of a method of preparing a product which may be described as "whole" rubber or desiccated latex, which contains all the constituents of the latex.

Latex is impinged from a jet on a rapidly rotating disc from the edge of which it is thrown off in a fine film or spray into a chamber into which hot air or other hot gases are passed. The fine particles of latex are thereby dried in the form of flakes or powder which can be pressed and shipped in blocks.

Vulcanised fibres.—An invention has also recently been patented for the absorption of rubber or fibres by treatment with latex. It is stated that fibres will absorb much larger quantities of caoutchouc or rubber when thus treated than by dipping or treating the fibres with a solution of rubber in a rubber solvent. This process may be of value in the preparation of fibres, cords, canvas, etc., for tyre and other manufactures.

PRELIMINARY NOTE ON THE "LESSER" COCONUT SPIKE MOTH.

By G. H. Corbett.

A NUMBER of enquiries has been received with respect to the importance of this insect as affecting the yield of coconuts and it is considered that a brief résumé should be given. Investigations of this insect have only recently been commenced and, as they continue, data may be found and observations made which may qualify some of the statements in this preliminary note.

Local History.

At the Malaya-Borneo Exhibition held at Singapore this year, amongst the entomological exhibits were specimens of coconut spikes, which aroused considerable interest, showing injury caused by the caterpillars of the "Greater" Coconut Spike Moth.

Later, the writer visited an Estate in Perak to report on an area of coconut palms, which, though producing healthy spikes, failed to set a large number of nuts. During this visit, caterpillars of the "Greater" Coconut Spike Moth and of the "Lesser" Coconut Spike Moth were found.

Owing to the caterpillars of the "Greater" Coconut Spike Moth not being observed on a tree producing no nuts an unopened spike was cut down. On examination whitish coloured cocoons were seen together with injury not only to the male but also to the female flowers.

Proceeding to the area of coconuts not yielding as well as other areas, further examinations of coconut spikes, especially those about to burst, were made, and in the majority or cases, caterpillars as well as pupae in cocoons together with signs of injury to both male and female flowers were in evidence. From two of the spikes opened a number of moths escaped.

As far as the writer is aware injury caused by the caterpillars of the "Lesser" Coconut Spike Moth to the flowers of the inflorescence, whilst still enclosed within the spathe, has not been previously recorded.

Economic Importance.

From field observations and examinations of spikes in the laboratory this insect would appear to be the principal pest of coconut spikes, as a large number of female flowers are found to be injured before the spikes have opened.

Two consignments of unopened spikes forwarded to the Department of Agriculture from an Estate showed the following results when opened :—

Total number of spikes	... ...	15
Do. injured female flowers	...	156
Do. uninjured female flowers	...	71
Percentage of injured female flowers	...	68.72
Do. uninjured female flowers	...	31.27

It should be stated that the percentage of injured flowers might have been greater if the spikes had burst of their own accord.

It is considered probable that damage to the inflorescence caused by this insect at such an early stage may prevent the female flowers maturing, for the following reasons :—

(1) Male flowers attacked frequently turn black and this discolouration would appear to continue down the stalk resulting in the dropping of many flowers.

(2) Female flowers are frequently noticed with a jelly like substance over their surface and it is possible that these will not open to allow of pollination, with the result that fertilisation does not take place.

(3) Female flowers having their scales and surfaces damaged by the caterpillars are liable to be exposed to bacteria and fungi with the ultimate non-setting of nuts.

Experiments are being conducted in the field in order to ascertain if injured female flowers can produce mature nuts, if uninjured female flowers on a damaged spike reach maturity, and if all female flowers on an undamaged spike reach maturity. Until results from these experiments have been obtained definite statements in connection with the importance of this insect cannot be made.

It should be stated that the writer has found the caterpillars of this moth on trees which were considered bearing well.

Distribution.

This insect has been found in Perak and Selangor and is probably distributed throughout Malaya.

Injury to the Flowers in the Spike.

Frequently when the spathes are cut open injury is not observed but by taking the inflorescence out of the spathe damage, confined essentially to the inside of the flowers, is noticed.

The damage is chiefly seen on the flowers at the basal half of the spike but the marks showing where the caterpillars have entered through the spathe are generally found at the apical half. This peculiarity is probably due to the growth of the spike after infection.

Brief Description and Life Cycle of the "Lesser" Coconut Spike Moth.

In the laboratory preliminary observations show that the eggs of this insect are laid on the spathe generally between the grooves where the tissue at the base is softer than at the surface. The egg is small, oval, and yellowish white in colour, and when about to hatch the caterpillar is seen doubled up inside it. The eggs hatch in from two to three days and the caterpillars boring through the spathe feed upon the flowers. The caterpillar is at first white in colour with a dark brown coloured head and with pale brown coloured bands between the segments. Before pupation the bands are greenish in colour and the larva measures about 8 mm. in length. The larval stage lasts from 5 to 8 days. When full grown the caterpillars pupate in white elongated cocoons generally at the base of the main flower stalk.

The pupal stage lasts from 6 to 8 days.

The moth has a wing expanse of 11 mm. Length at rest about 6 mm. The fore wings are light brown with small black spots. Both pairs of wings are fringed. The male is slightly smaller than the female.

Summary of Life Cycle.

			Minimum.		Maximum.
Egg Stage	...	...	2 days.		3 days.
Larval ,,	...	...	5	,,	8
Pupal ,,	...	...	6	,,	8
	Total	...	13	,,	19

Mention may be made that figures so far obtained of the life cycle of individuals indicate that the minimum length of time is 15 days, and the maximum 17 days: the majority 16 days.

Time Spikes Attacked.

In field observations on coconut trees carrying three unopened spikes, the youngest spike has not been noticed attacked, the middle spike shows slight feeding marks and spots on the inside of the spathe are conspicuous, whilst the oldest spike sometimes possess caterpillars pupae, and moths, but cocoons with pupae inside them are mostly in evidence.

From the study of the life cycle, and observations in the field, the eggs in nature would appear to be laid about fifteen days before the bursting of the spike, so that treatment to prevent either eggs from being laid or the caterpillars entering the spike should be done before the spike is more than half grown.

Control.

Control experiments are taking the form of (1) injecting substances into the spike, (2) spraying spikes with poisonous substances

and (3) painting the spathe with probable deterrents to the moths and substances affecting the eggs.

The writer is not at present in a position to give recommendations for the control of this insect. If this insect proves of importance, investigations and field observations will continue. Definite control measures may not be forthcoming for a considerable time, but injections with carbon bisulphide appear to cause too much damage to the inflorescences to be recommended as a control measure.

Note.—Besides the "Greater" Coconut Spike Moth another species of moth has been bred from opened spikes.

The three species of moths obtained from the spike have been forwarded for identification to the Imperial Bureau of Entomology.

Since writing the above the "Greater" Coconut Spike Moth has been identified by Dr. Guy A. K. Marshall as *Tirathaba* sp., near *trichogramma*, Meyr, and was unrepresented in the British Museum.

NOTES ON SISAL HEMP AND BOWSTRING HEMP.

THE following information in respect of Sisal Hemp (*Agave Sisalana* and Bowstring Hemp (*Sansevieria spp.*) has been received from the Directors of Agriculture, Kenya Colony and Tanganyika Territory in reply to enquiries addressed to them.

Sisal Hemp :—This plant is usually planted 8 ft. x 8 ft. or 680 plants per acre.

The plants usually pole in 5 to 7 years according to locality in Kenya Colony and give the following yields:—

YIELD OF LEAF PER PLANT.

		1st Class leaves.	2nd Class leaves.	Total.
3rd Year	...	37	58	95
4th ,,	...	28	42	70
5th ,,	...	22	30	52
6th ,,	...	18	25	43
Total	...	105	155	260

Average weight of leaf, 10¼ ozs.

Average fibre content 3.6 per cent.

Yield of fibre per acre is about 2¼ tons spread over the 3rd and 6th years.

The fibre is exported to Great Britain and Ireland.

Sansevieria :—This fibre plant is grown only under jungle conditions and the following varieties are known in East Africa- *Sansevieria Ehrenbergii* and *Sansevieria Sulcata.* It is not cultivated in Tanganyika Territory also, but is found in many parts. The fibre is not extracted as a commercial product but to a small extent by natives for domestic use. Its cultivation was attempted by the Germans but given up as unprofitable.

Europeans have also paid little attention to this plant in Kenya Colony owing to its slow growth and poor market prices. Attempts were made to ret it and to pass the fibre through machinery used for the decortication of Sisal Hemp but with unsatisfactory results. Natives on the Coast treat the leaves by beating, then retting for a day or two, and after further beating, wash out the fibre.

B. J. E.

NOTE ON JUTE AND GUNNIES.

(Abstract from Supplement to the "Indian Trade Journal," April 30, 1920 by J. C. Nixon, I.C.S. D.A. 881/22.)

THERE are two main species of Jute grown in India, *Corchorus capsularis*, with rounded capsules, and *Corchorus olitorius*, with long cylindrical capsules.

The former is the hardier species and in contradistinction to the latter can withstand submersion in water up to its middle when only half grown. *Corchorus capsularis* is also superior in colour and fineness and is less brittle, though it is usually inferior in length. *Corchorus olitorius*, however, though coarse, gives an excellent spinning fibre. Each species has early and late varieties, the latter yielding generally a heavier outturn.

The land is prepared by five or six ploughings just after the first shower of rain in the latter part of February or early March. Sowing extends from the middle of February to the end of May or even into June, but on low lands, liable to flood, sowing must be finished by the end of March. When the plants are 6 inches high a rake is drawn over the land two or three times for the purposes of thinning out and of loosening the earth. This process is not continued after the plants have reached a height of one foot. The seeds germinate in 2-4 days and the plants mature in from 12 to 15 weeks.

Jute is cut from the beginning of July to the end of September and sometimes in October. The bulk of the crop is harvested in August and early September. The jute season is reckoned from 1st July to the following 30th June.

The jute fibre is contained in the bark and is associated with a gummy pectose, this has to be softened by a fermentation process. The stems are freed from leaves and side branches and the resulting long wands are tied into bundles, which are occasionally stacked for two or three days. They are then kept under water for usually from 10 to 12 days but occasionally for as long as a month. The process is called steeping or retting. The fibre must be separated from the stem within a couple of days after the retting is complete. The methods employed for this purpose are:

1. To take each stem separately and strip it by hand.
2. To beat a bunch with a wooden mallet.
3. To dash a handful on the surface of water.

The separated fibre should be washed in clean water, if possible. The water is wrung out of the fibre which is then thrown down to dry and bleach in the sun for two or three days. The usual length of the fibre is six to nine feet, if it is below six feet it is called short. For purposes of forecast the yields are reckoned at from 1,200—1,500 lb. per acre.

Jute comes into commerce in the following forms:—

1. Loose Jute.

   (*a*) In drums weighing 30—40 seers each (60—80 lb.) and roughly assorted.

   (*b*) In 'kachha' bales weighing about $1^1/_2$ maunds (about 123 lb.) assorted and hand-pressed, or $3^1/_2$—4 maunds assorted and power-pressed.

2. Baled, *i.e.* as 'pakka bales' each weighing approximately 400 lb. and pressed in a hydraulic press to occupy about $10^2/_5$ cubic feet.

Jute goes to the local mills in any of these forms but usually as kachha bales. It is exported to foreign destinations only in the form of pakka bales. The pakka baling presses are mostly in Calcutta but there are some at Dacca, Chandpur, and Naraingunj. Kachha baling presses exist all over the jute area—Bengal, Assam and Behar and Orisa.

In the loose state jute is usually known according to the locality in which it is grown or rather according to the local market in which it is sold. In the local market it is bought by weight according to the local maund. It is brought to market in bundles of which the size and weight vary from locality to locality.

In use, jute is classified as follows:—

1. *Hessian warp* which is strong, healthy and fine jute of good gloss and silvery white colour with no specks or sticks in it. It is used for spinning thread which is suitable as warp in weaving hessian cloth.

2. *Hessian weft* which is inferior to hessian warp in colour and gloss but is otherwise similar. It is used as the weft in hessian cloth.

3. *Sacking warp* which is strong and healthy jute, irrespective of colour and coarser than (1) or (2). The thread spun from this is used as warp in weaving cloth for the manufacture of sacks and bags.

4. *Sacking weft* is composed of the dull coloured, short or weak jute remaining after the three grades above enumerated have been selected from the bulk. This jute is used in the manufacture of cloth for the heavier grades of sacks and bags. The term sacking weft may generally be taken to include:—

   (*a*) *Rejections* which are either damaged or barky or knotty. Rejections have to be particularly well batched before they can be used even for the inferior cloths.

(*b*) *Cuttings* represent the jute cut off from the ends either at the time of assorting pakka bales for shipment or when selecting jute at the mills intended for the manufacture of hessians and the better grades of sacking goods. Clean workable cuttings are largely used in the preparation of sacking warp while the inferior low grades are commonly utilised for paper-making.

In practice there is no hard and fast line between any successive pair of the above four groups.

In Loose jute the cuttings are always still attached to the main fibre. It is quoted by the Calcutta Bazar maund which is equal to 82 lb. 4 oz. 9 dr. In contracts it is usual to specify to probable yield of the bales, thus—

......per cent. good hessian warp

......per cent. good sacking warp

......per cent. weft and cuttings

Drums and bales are divided into.

1's containing all hessian warp (in the trade these are practically unknown).

2's containing 20% good hessian warp, 60% good sacking warp and 20% weft and cuttings,

3's containing 70% sacking warp and 30% weft,

4's containing 40% sacking warp and 60% weft

Rejections are usually marked R's and a reliable packing usually containins 20% sacking warp.

These different qualities are sometimes represented by letters instead of by figures and sometimes intermediate numbers are given.

As a matter of fact these classifications are largely theoretical. Formerly the system may have held but most balers now sort and bale according to their own special standards to which they give numbers. The best that can be said of a particular number is that a 2 is better than a 3 and so on and that the reputed 2 of a well known baler is never inferior in its yield to the theoretical 2.

The standard quality of the loose jute market was formerly 50/50 meaning that 50% of the bales were 2's and 50% 3's. 50/50 when quoted at the present time more usually means 50% 3's and 50% 4's. The standard quotation of the present time is, however 4's. The standard of the grades is improving yearly, so much so that a 3 of to-day is as good as a 2 of a few years ago.

Baled jute is quoted by the bale of 400 lb. nett or including tare 405 lb. For the purpose of freight calculation five bales are guaranteed to occupy not more than 52 cub. ft. per ton at the time of delivery from the press house and not more than 54 cub. ft. per ton alongside the exporting vessel. In the case of 'pakka' bales there are various grades, the packing of which is carried out to regulated standards of quality recognised in the local and overseas markets.

As in the loose jute market, the quality of a particular baler's particular mark becomes known apart from any alleged grouping and it is bought on its reputation, although in contracts for the supply of pakka bales to jute mills it is not uncommon to guarantee certain percentages, say of Hessian warp and Sacking warp.

It is interesting to note the number of hands through which the marketing of jute passes or may pass :—

1. The cultivator or raiyat who produces it. He either brings his jute to the local market and sells it, or very frequently sells it while the crop is on the ground, receiving either the whole or part payment in advance.

2 & 3. The 'Vepari' who acting as buying agent for the 'mahajan' and with money advanced by the mahajan without interest bargains with the raiyat for the purchase of the jute and pays ready money for it.

4. The mahajan either sends his goods in drums to an 'arathdar' in Calcutta or makes them over to an arathdar in the local markets. The arathdar has a godown. He ordinarily does not purchase the jute, but acts as commission agent between mahajan and baler. He charges commission and godown rent and is responsible for the recovery from the baler of the price of the goods sold.

5. The baler, kachha or pakka, who bales the jute in a press.

6. The underbroker who offers on behalf of the baler the baled jute to the broker.

7. The jute broker who finds buyers who may be mills or shippers or pakka balers.

8 & 9. The shipper who ordinarily does not possess his own ships and arranges shipping space through a freight broker.

10. The foreign purchaser or the jute mill.

In actual practice many of these links are omitted.

The United Kingdom is the largest purchaser of raw jute and before the war was followed by Germany, the United States, France,

Austria-Hungary and Italy. In 1913, for instance, the United Kingdom imported over 350,000 tons valued at £9,246,598, nearly all from India, of this about 130,000 tons was re-exported as raw jute and valued at £3,475,298. During the 1913-14 season, the total export from India was 768,451 tons, of which the United Kingdom took 290,369 tons, Germany, 158,380 tons and the United States 117,744 tons. The export of raw jute has fallen off considerably since then, the total export for 1918-19 being 398,146 tons.

In addition to raw jute India exports large quantities of gunny cloth and gunny bags. In 1913-14 over a thousand million yards of cloth were exported, the United States taking over 70% and the Argentine over 15%. The figures for 1918-19 are very similar, except that the United Kingdom took nearly as much as the Argentine.

During the 1913–14 season 368,759,260 gunny bags were exported of which Australia and New Zealand together took nearly 79 million, the United States 58 million, Chili 36 million and the United Kingdom 27 million. In 1918–19, the total export was over 583 million bags, of which Australia and New Zealand again took 79 million, the United States 46 million, the United States 46 million, Chili 48 million while the United Kingdom imported no fewer than 135 million and Egypt 82 million. The imports into the last two countries doubtless included large quantities of sand-bags in the latter year.

INK FOR WRITING ON ZINC LABELS.

THE following recipe for an ink which can be used for writing on zinc labels is published for information.

This ink has been prepared and tested locally with satisfactory results and has been found an efficient substitute for the more laborious methods of either painting or stencilling.

		Ozs.		Drs.
Verdigris	...	0	...	2
Sal-ammoniac	...	0	...	2
Lampblack	...	0	...	1
Water	...	4	...	—

The ingredients are mixed in a mortar, the water being added gradually. The ink should be kept in a glass stoppered bottle and applied with a quill pen. Previous to writing the zinc should be polished with a little fine emery paper.

This recipe was obtained from "Recipes for the Colour, Paint Varnish, Oil, Soap and Drysaltery Trades" published by Scott, Greenwood & Son, London.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of May, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun	Temperature. Mean Dry Bulb.	Temperature. Maximum	Temperature. Minimum	Temperature. Range	Hygrometer. Mean Wet Bulb	Hygrometer. Vapour Tension.	Hygrometer. Dew Point	Hygrometer. Humidity	Prevailing Direction of Winds.	Total Rainfall	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	144.61	83.2	91.7	74.6	17.1	77.3	.820	73.3	72%	...	8.31	2.22
Pahang, Kuala Lipis	...	...	81.4	90.6	71.5	19.2	76.6	...	...	...	...	6.87	3.19
Johore, Johore Bahru	...	...	...	89.1	73.9	15.2	...	...	...	...	...	5.28	1.49
Singapore, Kandang Kerbau	1013.2	...	82.5	83.7	78.2	5.5	75.1	.917	...	85.	Calm.	14.08	4.92
Malacca, Durian Daun	1017.5	122.	83.	89.	74.	15.	79.	.925	...	80.	N. W.	6.18	2.08
Negri Sembilan, Seremban	...	156.4	80.1	91.6	75.	16.6	75.3	.791	73.	75.9	N. W.	4.19	1.45
" Kuala Pilah	...	153.1	83.	91.3	71.6	19.7	78.7	.896	75.9	80.2	...	2.68	.92
" Port Dickson	...	160.9	83.8	89.9	75.7	14.2	79.9	.898	75.9	77.4	...	3.68	.78
Selangor, Kuala Lumpur	...	148.8	83.0	90.5	74.0	16.5	77.3	.830	73.5	73.	S. E.	6.23	1.94
" Klang	...	...	81.7	86.5	74.8	11.7	77.3	...	..	...	...	3.22	1.20
" Kuala Selangor	...	...	...	90.0	70.0	20.0	...	...	...	...	...	4.03	1.20
" Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Telok Anson	...	...	81.94	93.	70.	23.	78.18	.914	...	85.	...	4.64	1.41
" Ipoh	...	...	81.79	95.	70.	25.	76.92	.862	74.51	80.	...	6.85	2.00
" Taiping	...	...	82.20	93.	71.	22.	77.43	.878	...	81.	...	23.93	3.62
" The Cottage	...	...	...	...	...	...	...	...	...	...	...	38.93	7.99
" Parit Buntar	...	...	82.79	92.	71.	21.	78.42	.915	...	83.	...	12.12	2.79
Penang, George Town	1009.3	153.	81.3	94.	70.	24.	78.6	.912	73.	88.7	N. W.	12.93	2.32
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	18.61	3.89
Perlis, Kangar	...	...	..	88.7	74.	14.7	...	...	...	...	...	9.34	1.70

THE

Malayan Agricultural Journal.

Vol. X. JUNE, 1922. No. 6.

EDITORIAL NOTES.

THE Netherlands Indies Review published by the British Chamber of Commerce for the Netherlands East Indies is an interesting monthly paper. In the Trade Review for 1921 which appears in their issue for June, 1922 the following note on Kapok appears :—

KAPOK .

This might be mentioned as perhaps the only article that could resist the great fall in prices, to which almost all products of the Dutch Indies were subject last year. Together with high prices we may speak of a satisfactory turnover, especially in this country, although in the second half of the year Germany completely fell away as a purchaser.

FIBRE BALING PRESS .

With reference to the editoral note in this Journal Vol. X, No. 3, March 1922, giving the capacity of the fibre baling press, it has since been found possible to prepare bales measuring 3 ft. 7 ins. × 2 ft. 7 ins. × 2 ft. (*i.e.*, 18.5 cubic feet) containing 420 lbs. of fibre, with a compression on the ram of 80 kilogrammes per sq. cm. This represents 1110 lbs. of fibre or almost exactly ½ ton per 50 cubic feet, and represents a considerable saving in shipping space over the figures quoted previously.

PALM OIL AND INTERNAL COMBUSTION ENGINES

With reference to the information contained in the Agricultural Bulletin Vol. IX, No. 2, 1921, on the use of palm oil as a fuel for internal combustion engines the following information received from Messrs. Roby & Co., Ltd., of Lincoln, England in respect of engines manufactured by this firm may be of interest.

The features claimed for these engines are :—

(*a*) low fuel consumption

(*b*) water injection is not used to obtain full load

(*c*) sensitive governor regulating the supply of oil according to load

(*d*) large cylinders per horse power

(*e*) margin of power for overloading.

It is stated that any grade of oil can be used in these engines the consumption of crude oil being about O. 55 lbs. (½ pint) per B.H.P., per hour.

The fuel consumption, using palm oil, is stated to be 0. 6 to 0. 65 lbs. per B.H.P., per hour. No alterations are necessary for running on this oil, while no water injection is required.

It might perhaps be advisable to mention that the above information in respect of a particular type of engine is given on account of the fact that these engines have been tested and advertised as suitable for palm oil as a fuel.

Further details in respect of the cost of these engines of different horse power can be obtained on application to the Secretary for Agriculture. (Quote D.A. 1191/22).

SELECTED WET PADI SEED.

The Department of Agriculture has still a limited stock of seed of selected pure strains of several varieties for sale at .14 cts. per gantang F.O.R. Parit Buntar. These strains vary in maturation period from five and a half to eight months. Applicants should apply direct to the Economic Botanist, Department of Agriculture, Kuala Lumpur stating their requirements and the district in which it is desired to sow the seed.

PLANTING MATERIAL.

On page 171 of this journal will be found a Price List of Planting Material, both of Economic and Non-economic plants, obtainable from this Department.

Seed of the following crops can be obtained from the Manager, Fordson Estate, Bagan Datoh.

> Jute (2 varieties), Roselle (Green), Mauritius Bean, Centrosema, Indian Tobacco and Kapok. Kapok seedlings are also obtainable from the same estate.

OBITUARY.

The late Lawrence Lewton Brain, B.A., F.L.S., Technical Adviser, Department of Agriculture, F.M.S. and S.S.

We have to record with deep regret the death of Mr. L. Lewton Brain, B.A., F.L.S. formerly Director of Agriculture, F.M.S. and S.S. and more recently Technical Adviser, Department of Agriculture, F.M.S. and S.S. which occurred at the European Hospital, Kuala Lumpur on the 24th June at the early age of 43.

Mr. Lewton Brain who had returned from long leave as recently as April, died of heart failure following an attack of malignant malaria.

Mr. Lewton Brain was educated at St. John's College, Cambridge, and was appointed subsequently Junior Demonstrator of Botany in the University. In 1902 he was appointed Mycologist and Lecturer in Agriculture to the Imperial Department of Agriculture for the West Indies.

He resigned his appointment in 1905 on being offered the appointment of Assistant Director in the Division of Pathology and Physiology at the Experiment Station of the Hawaiian Sugar Planters' Association.

In 1910 he accepted the post of Director of Agriculture, F.M.S. and arrived in November of that year.

In 1919 he was appointed Director of Agriculture, F.M.S. and S.S. when the activities of the Department were extended to include the Straits Settlements as well as the Federated Malay States.

During his tenure of office as Director, the activities of the Department were considerably extended and the staff increased and organised to meet the great developments in the Agricultural Industries of Malaya, particularly in respect of rubber cultivation. Had it not been for the war, there is no doubt that the development of the Department and the results of its work would have been far greater, since many of the appointments sanctioned in 1914 were not filled until 1921 and 1922, and almost every Division was single-handed. At the time of his death the Department was one of the best equipped Departments of Agriculture in the Colonies and Protectorates of the Empire.

On the abolition of the appointment of Director in 1922 Mr. Lewton Brain was appointed Technical Adviser, which post he held at the time of his death.

During his tenure of office he earned the respect of the European, Malay and other Asiatic officers of the Department. The officers of the Department offer their deepest sympathies to his wife and children in their bereavement.

THE PRESERVATION AND PACKING OF LATEX FOR SHIPMENT.

By B. J. Eaton.

THE most satisfactory preservative for latex, as far as is known at present, is Ammonia.

Experiments are being carried out with other substances as a substitute for ammonia, since this chemical is somewhat dangerous to handle and is expensive, especially at the present local price.

There is a number of substances which can be used in lieu of ammonia ; and which are more satisfactory and economical, but until further information is available as to the purposes for which consignments of latex are required and the subsequent treatment to which the latex is subjected it is not advisable to add these, except in the case of small samples sent as experimental shipments.

Thus sodium hydroxide and carbonate can be used, while potassium cyanide, in very small quantities, is an excellent "preservative" but probably too dangerous to use. Preservatives such as boric acid are practically useless. Sodium 'phenate will probably prove an excellent chemical, provided the free alkali is subsequently neutralised. Small quantities of the soluble fluorides (sodium, potassium and ammonium fluorides) may also prove suitable and economical.

At the present time however, the use of ammonia is advocated and the following recommendationo are made :—

Ammonia may be used

(a) in the form of the strong solution known in commerce as Liquor Ammon Fortis.

(b) in the form of gas obtained from cylinders of the compressed gas.

(c) generated as a gas from salts of ammonia, e.g. ammonium sulphate or ammonia chloride, in an apparatus on the estate.

Liquor Ammon Fortis.

The strongest solution of ammonia on the market is Liquor Ammon Fortis which has a density of 0.880 and contains about 35 per cent. by weight of NH_3 (Ammonia) gas.

Liquor Ammon Fortis (B.P.) has a density of 0.888 and contains 32.5 per cent. of Ammonia gas by weight.

The solution however is saturated at a lower temperature in a cold climate, so that when it reaches the tropics in sealed drums or bottles, the solution is supersaturated and consequently under pressure.

When drums or vessels containing the solution are opened at the average shade temperature in this country, a large portion or even the whole of the contents of the vessel may spout up in the form of a strong fountain and if the operator opening the vessel is standing or leaning over the opening, he may receive the charge in his face, and may be rendered blind or otherwise hurt.

When opening such drums therefore, it is advisable to stand the drum in a tank of cold water, immersing the drum to about three quarters of its height. The stopper should be carefully unscrewed and the operator should do this by standing or sitting at arm's length from the drum.

Method of Application: - The solution of ammonia should be added to the extent of 2 per cent. on the volume of latex or say 3¼ fluid ozs. or 8 ozs. by weight per gallon of latex. (Note. - The writer has examined a sample of ammonia recently, which contained only 20 per cent. instead of 32.5 per cent. of ammonia (NH_3). Even after making allowance for the loss of gas at the higher tropical temperature, the strong solution should contain about 28 per cent. of ammonia gas).

AMMONIA GAS IN CYLINDERS

The writer has found that the compressed gas in steel cylinders, which is used in this country for refrigerating purposes, can be substituted satisfactorily for the strong solution. The use of the strong solution-Liquor Ammon Fortis-or the compressed gas is principally a matter of relative cost. Approximately one-third of the weight of ammonia gas is equivalent to the strong solution of Liquor Ammon Fortis.

Thus, if Liquor Ammon Fortis can be purchased at $5 per gallon, (9 lbs. approximately) i.e. at $1.65 per 3 lbs., Ammonia gas in cylinders must be less than $1.65 per lb. in order to be more economical for use.

The gas may be used either by making a saturated solution by passing it into water or by passing the gas direct into latex.

Since the addition of less than 1 per cent of the gas is required in latex, there would be no loss of gas and very little heat developed by passing the gas direct into the latex in large tanks. The writer favours this method.

If the gas is passed from the cylinders into water in order to make a saturated solution, which can be added subsequently to the latex, the most satisfactory method is to attach a series of branch pipes to the main exit pipe from the cylinder and to lead these branch pipes nearly to the bottom of a large vessel or series of vessels, e.g. 4 gallon kerosene tins, containing water. An alternative method is to connect the main

pipe from the cylinder to a T piece of piping of suitable length, the head of the T piece being perforated to allow the gas to escape through the perforations.

The absorption vessels containing water should be placed preferably in a large tank through which cold water is run continuously, so that the heat developed during the absorption of the gas by water is not too great. This method has worked quite satisfactorily and a saturated solution containing about 17 per cent of ammonia gas has been prepared in this way on an estate.

Provided there is no leakage in the connecting pipes and when large quantities of latex are treated direct with the gas from the cylinders, the amount absorbed by the latex can be determined with sufficient accuracy by the loss of weight of the cylinder of gas : 1 lb Ammonia gas is sufficient for 16 gallons of latex.

PREPARATION OF AMMONIA GAS FROM SALTS OF AMMONIA (AMMONIUM SULPHATE OR CHLORIDE) ON THE ESTATE.

Although this method has not yet been adopted in practice, the writer considers that the most economical method would probably be to import ammonium sulphate or chloride, which are not dangerous chemicals from a shipping or any other point of view, and to prepare ammonia gas direct on the estates in a small apparatus which can be designed fairly easily.

The only other chemical required is quick or slaked lime which is readily obtainable.

By heating these two compounds together, i.e. slaked lime with ammonium sulphate or chloride, ammonia gas is generated and with a safety gauge between the generator vessel containing the latex, to prevent any back suction, the gas can be passed direct into the latex.

If there is no leakage in the apparatus, the amount of ammonium salt and lime (the latter in excess) required for any particular volume of latex can be easily determined.

LATEX

In order to save freight on water, the latex, which is to be preserved for shipment, should be collected "dry" and should contain at least 3 lbs of dry rubber per gallon (This should be feasible except on a wet day). The latex should be strained carefully and the ammonia added as soon as possible after the latex reaches the factory, in order to inhibit preliminary fermentation and formation of acid in the latex.

PACKING FOR SHIPMENT.

Latex preserved by one of the methods described above can be shipped

(a) In kerosene tins carefully sealed by soldering, packing 2 a wooden box or crate so that they fit tightly.

(*b*) In steel drums.

(*c*) In tanks or tank steamers.

The vessels (tins or drums) containing the latex should be cleaned thoroughly before being used.

If the drums or tins contain traces of oil, this can be removed by blowing steam into them.

Remarks:—Recently, Liquor Ammon Fortis (the most concentrated solution of ammonia obtainable has been sold locally at $5/- per gallon, but it is understood that it can be obtained and sold locally at about half this price.

Compressed ammonia gas contained in cylinders cost recently $1.70 per lb., excluding the price for the cylinder, which is returnable.

NOTE:—The writer has been informed recently that a London quotation has been received offering Liquor Ammon Fortis (0.880) C.I.F. Port Swettenham at £57. 5s. per ton which is equivalent to $1.93 per gallon or considerably less than half the present local price.

A CONSIDERATION OF RECENT WORK ON THE BROWN BAST PROBLEM.

By A. Sharples.

THE recent depression in the rubber industry has produced results far-reaching in many directions and has considerably affected the relation of the industry to scientific research. During the period when each pound of rubber yielded a large profit Brown Bast was one of the most important disease problems. Under a profitable regime, estates were prepared to try for maximum yields with, in the majority of cases, a resultant large increase in number of Brown Bast cases. Under such circumstances, this problem was urgent, but with decreased demand and a call for restriction Brown Bast has not been so much in evidence.

A Brown Bast Investigation Committee was formed in 1918 in Malaya. The following gentlemen served on the Committee at its inception:—

Mr. F. W. South	-	Chief Agricultural Inspector, F.M.S. (*Chairman.*)
,, W. N. C. Belgrave	-	Acting Mycologist, F.M.S.
,, G. E. Coombs	-	Government Botanist, (*Secretary.*)
,, A. G. G Ellis	-	Assistant Agricultural Inspector, Perak, F.M.S.
,, W. M. Miller	-	Mycologist, Carey Island Rubber Estates
,, F. de la Mare Norris	-	Assistant Agricultural Inspector, Negri Sembilan, F.M.S.
,, H. C. Pinching	-	Mycologist, R. G. A., Ipoh.
,, G. E. Perry	-	Mycologist, Societie Financiere, Kuala Lumpur.
,, R. M. Richards	-	Mycologist, M. P. A., Caledonia Estate, Province Wellesley.
,, H. Sutcliffe	-	Mycologist, R.G.A., Petaling.
,, H. H. Stirrup	-	Acting Assistant Agricultural Inspector, Johore.

Other gentlemen who served on the committee were Mr. B. J. Eaton, Agricultural Chemist, F.M.S., Mr. A. L. Sanderson, Mycologist, R. G. A., Petaling, and the writer, who on arrival in Malaya in 1920 was co-opted a member of the committee.

Many changes took place between 1918-20 owing to officers taking leave. Mr. R. M. Richards was Chairman for a part of the time after Mr. South had gone on leave. In 1920 only two meetings were held and as the attendance was poor and no concerted efforts were being made, the committee practically disbanded by default.

The meetings were held in the offices of the Department of Agriculture, Kuala Lumpur, F.M.S. and the minutes recorded and kept there. The last meeting took place in February 1920, when the chairman, Mr. R. M. Richards promised to write up and publish the minutes, to indicate the work attempted and done. Owing to ill-health Mr. Richards went suddenly to England and as no information is forthcoming as to his attempt to collect the information contained in the minutes of the committee, the writer, with the permission of the Acting Director of Agriculture, Mr. B. J. Eaton decided to give a resumé of the work done in Malaya. This is of more importance in view of several articles recently published by Rands (1), Sanderson and Sutcliffe (2), and Farmer and Horne (3 & 4.)

The work of Rands was contemporary with that of the Brown Bast Investigation Committee (B.B.I.C.) and in many cases similar lines were followed. It will be interesting to indicate the issue of results in Java and in Malaya.

EXPERIMENTS TO ISOLATE A CAUSAL ORGANISM.

Rands (loc cit) details numerous attempts to isolate a causal organism but concluded that no organism was secured with sufficient consistency to warrant suspicion as a possible cause. The experiments carried out by the various members of the B. B. I. C. of Malaya, to be detailed below, support Rand's conclusions.

Previous to the formation of the B. B. I. C. in Malaya, Belgrave (5) had suggested a *Spongospora* sp. (or lowly Alga) which he had observed in diseased tissues, as a possible cause. Further work led him to abandon this view. On the formation of the B. B. I. C. various members were delegated to attempt to isolate a causal organism. Various media were used for the isolations and a summary of the organisms isolated is given :—

(1) Large Bacterium.

(2) *Pestalozzia* Sp.

(3) Bacillus giving white, glistening colonies on agar—this organism was often obtained from burred tissue.

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(1) Rands. R D.:—Brown Bast Disease of Plantation Rubber Its Cause and prevention; Archief Voor de Rubber Culture in Nederlandsch-Indie. 5c. Jaargang. No. 5 Mei, 1921.

(2) Sanderson A. R. & Sutcliffe H: Brown Bast An investigation into its causes and method of treatment. 7/6 net. Rubber Growers Association 38 Eastcheap London E. C. 3.

(3) Farmer J. B. & Horne A. S: Phloem Necrosis Brown Bast Disease in Hevea brasiliensis; Annals of Botany Vol. XXXV. No. CXXXIX July, 1921.

(4) Farmer J. B & Horne A.S.: On Brown Bast and its immediate cause; India Rubber Journal Vol. LXI No. 25 June 18, 1921.

(5) Belgrave W. N. C:—A preliminary Note on Brown Bast. No. 1 Vol. VI. Agricultural Bulletin F. M. S. October. 1917.

(4) A Coccus form or possibly a Streptococcus, accompanied by a small number of larger bodies, possibly spores.

(5) A large hyaline Yeast-like organism.

(6) A large spore-like Bacterium, different from (5),

(7) An unidentified fungus peculiar in that the hyphae in agar soon disintegrate, leaving only a few crystals.

(8) *Hormodendron Sp.*

(9) From scaled bark :—

(a) A Basidiomycetous fungus.

(b) *Mucor Sp.*

(c) A fungus with pycno-and stylospores.

(d) A green Bacillus.

(10) Isolations made from longest infected spots gave *Trichoderma viride* in many cases.

This long list undoubtedly supports Rands conclusion stated above.

Experimental Inoculations and Attempts to Transfer Brown Bast from Diseased to Healthy Trees.

The proof of an organism causing a disease depends largely upon the results obtained by inoculating healthy trees with pure cultures of the suspected organism. Rands (loc. cit.) details numerous and varied attempts to inoculate healthy trees artificially and endeavoured to set up Brown Bast symptoms by transference of diseased tissue to healthy trees. Similar experiments were tried by the B. B. I. C. and the results obtained in the two series were in entire agreement. The B. B. I. C, worked with a larger variety of organisms in pure culture ; in some cases promising results were obtained.

The organisms, listed above, were isolated from bark, both lightly and badly affected, and from soil surrounding the roots of diseased trees. All inoculations were negative in outcome. With Nos. (2) & (4) discolorations were obtained, but these did not progress. At first, encouraging results were on hand with No. (10). (*Trichoderma viride*) but again, final results were negative.

Rands performed inoculation experiments with Bacteria isolated in Sumatra by Keuchenius. This author claimed (1) that his inoculation experiments argued against a physiological cause. Rand's inoculation experiments with the cultures obtained from Sumatra gave entirely negative results, even after repetition to allow for the objections raised by Keuchenius regarding the first series. The B. B. I, C. wrote for cultures to be sent over from Sumatra but it was not a convenient time for despatch. However, the reply from Mr. Carl De La Rue contained a further expression of faith in a Bacterial origin of the disease.

The inoculation experiments with pure cultures were unsuccessful both in the case of Rands and of the B. B. I. C. This point being reached it became necessary to attempt to transfer the disease from affected to healthy trees by other methods. The attempts made in Malaya practically parallel those made by Rands in Java. A short summary of the later experiments will be useful to compare with the Malayan results.

(*a*) Diseased bark ground up and washed in sterile water. 5 c.c portions were injected into the bark of 22 seedlings. 17 controls were injected with sterile water. Results negative. Similar results were obtained in Malaya.

(*b*) Material from a case of Brown Bast a few weeks old macerated in water and plastered into wounds on trees 10 years old. 78 inoculations were made and 70 controls kept. Discolorations were noticable but of a purely local nature and as no spread was visible after a year, this could not be considered Brown Bast. This sound conclusion has some bearing on the experiments carried out by Keuchenius. The results obtained in Malaya by similar experiments support Rands conclusion.

(*c*) Previously untapped trees were used in this experiment and inoculations were made in wounds as follows:—

(1) Diseased bark macerated in sterile water and 132 inoculations made in 28 trees.

(2) Diseased bark macerated and sterilised in the autoclave for thirty minutes at 3 kg. pressure. 100 inoculations made in 25 trees.

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(1) Keuchenius P. H.—Onderzoekingen over Bruine Bastziekte. Archief Voor de Rubber Culture in Norderlandsch-Indie, Jaargang 4 Feb. 1920 No. 1.

(3) Healthy bark unsterilised, macerated. 100 inoculations in 25 trees.

(4) Healthy bark macerated and sterilised. 100 inoculations made in 25 trees.

(5) Sterile pads of absorbent cotton were soaked in sterile distilled water. 68 inoculations made in 17 trees.

Similar results were obtained as in a previous experiment (Supra) Discolorations were observed around the places of inoculation; the wounds to which rain water penetrated showed most reaction but no real Brown Bast was obtained. The same results were obtained in Malaya with similar experiments.

(*d*) Grafting and transplanting diseased bark in healthy trees.

An attempt to transfer the disease by transplanting and grafting diseased bark in healthy trees was made. Rands reports that practically all the grafts failed to connect up completely but there was no spread of the disease.

In Malaya, successful grafts were obtained but again there was no spread of the disease.

(*e*) Experiments (b) & (d) were repeated on previously untapped trees. These trees were previously subjected to heavy tapping in an attempt to weaken them so that any weak parasite might have a better chance of establishing itself. Results were again negative.

There is no record of a similar experiment in Malaya. The B. B. I. C. instituted a long series of experiments to test the action of various solutions when injected into the bark of healthy trees. The first series was made by inserting tubes, containing the various solutions, in holes made in the bark with a cork borer of equal diameter to the tube, which was fixed in place with plasticene.

The solutions tried were :-

(1)	Cane Sugar................................	5%	solution.
(2)	Glucose......................	5%	,,
(3)	Chloroform Water........................		
(4)	Sodium Carbonate........................	2%	,,
(5)	,, Chloride..........................	2%	,,
(6)	Acetic Acid................................	10%	,,
(7)	Citric Acid................................	10%	,,
(8)	Hydrochloric Acid,........................	0.5%	,,
(9)	Phosphoric Acid..........................	5%	,,

(10) Oxalic Acid.............................. 10% solution.
(11) Lactic Acid.............................. 10% „
(12) Tartaric Acid............................ 10% „
(13) Nitric Acid.............................. 0.5% „
(14) Sodium Hydroxide........................N/20 „
(15) Ammonia Water..........................0.5% „
(16) Mercuric Chloride.....................1 in 1000 „

No definite re-action was noted with any of these solutions. Further experiments were made using small plaster of paris casts impregnated with Chloroform, Ether, Ammonia, Prussic Acid, and Hydrogen Peroxide, which were placed in close contact with wounded bark. No re-action was noted with these substances except in the case of Prussic Acid, when a marked poisoning effect was noticable.

The total failure of the numerous attempts to transmit the disease by artificial methods led to the suggestion, emanating from Belgrave (vide Rands), of a "non-infectious disease of physiological origin." This suggestion stimulated research along different lines and the general result can be stated that all experiments tend to support this view.

Keuchenius (loc. cit,) has steadily supported the opposite view of a possible Bacterial origin of Brown Bast. The writer has referred above to the inoculation experiments published by Keuchenius and on the data presented he states that "attention to the infection theory and more experimental Bacteriological work on Brown Bast is necessary and the fact that bacteria can be isolated from Brown Bast is very strongly against the physiological theory but does not prove that those Bacteria are the cause of Brown Bast."

Keuchenius bases these statements on certain inoculation results. These results show that 40 inoculations with Bacteria were made and 40 controls were kept. In both series discolorations progressing from the place of inoculation were obtained. The length of the discoloration in both series was totalled; The total for the inoculated series was 177.5 cm. and for the controls 59.5 cm. The difference between those numbers is considered sufficient justification for the above statements.

A different interpretation, and a more acceptable one, can be placed on these results when subjected to analysis. This shows that 20 of the bacterial inoculations showed increase in length of discoloration as compared with the controls, while 16 of the bacterial inoculations show no difference and the remaining 4 show that the controls have an increase in length of discoloration over the bacterial inoculations. Thus there are 20 positive and 20 negative results. The writer would suggest as the only logical conclusion that such results cancel out. Of the positive results, only 12 show a difference greater than 6 cm. over the controls, and investigators with experience of inoculation experiments on *Hevea brasiliensis* would

hesitate to consider less than 6 cm. a positive result. The response of individual trees, even to slight wounding, as indicated by the amount of discoloration, differs widely and it may be suggested that this individual variation might account for some of the differences. The above inoculation results are not substantial enough to influence the work of other investigators.

Experimental Production of the Disease.

This heading indicates one of the most important and interesting parts of Rand's work in Java. The failure of his numerous and varied attempts to isolate a causal organism led him to attack the subject from a different angle. His experience indicated that heavy tapping i.e. overtapping, had a considerable significance when a heavy percentage of Brown Bast infection occurred. Working on this line he performed the following experiment.

Three adjacent rectangular blocks of 50 trees were taken as Groups *A.*- -*B.* *C.*: —

Group A · —Tapped six times a day at two-hour intervals beginning at 6 a.m. The system used was two cuts on 1/3 of the circumference at a height of 1½ metres. The results showed 40% of typical Brown Bast trees in two weeks, 50% at the end of four weeks 60% in 8 weeks.

Group B.: -Tapped once per day on the same system as Group A. at 6.30 a.m. The result showed 2% Brown Bast after 4 weeks, 4% after 6 weeks and 10% after 8 weeks.

Group C. . —Tapped six times per day as in Group A but only on ¼ cut at a height of 50 cm. The result showed ony 2% of Brown Bast during the month it was tapped.

This was the first successful attempt to produce Brown Bast artificially and Dr. Rands is to be congratulated on opening a new avenue by which knowledge could be gained.

A noticeable feature in the above tapping experiments in Group A. was that the disease usually appeared about the middle of the upper cut. Hamaker has recorded a similar observation on estates tapping on two superimposed cuts. He says that 72% —83% of his affected trees becom diseased on the upper cut.

The Brown Bast Investigation Committee in Malaya instituted experiments along similar lines, It was found however, that otapping 6 times a day did not work satisfactorily as no latex was obtained from the later tappings. Belgrave suggested as an alternative, one cut on a full spiral daily.

Experiments were set up to test the comparative effect of daily, alternate day and every third day tapping, on full spiral, half spiral and a ¼ cut. The results are tabulated. Yields were also kept.

System.	Month.	Brown Bast.	No. of trees tapped.
¼ Cut Daily tapping	April 1919 ..	—	515
,, Alternate day tapping ...	,, ...	—	530
,, Every third day ...	,, ...	—	502
½ Spiral Daily tapping ...	,, ...	—	341
,, Alternate day tapping	,, ...	—	331
,, Every third day ...	,, ...	—	350
Full Spiral Daily tapping ...	,, ...	—	536
,, Alternate day tapping	,, ...	—	517
,, Every third day ...	,, ...	—	538
¼ Cut Daily tapping	End of Sept., 1919 ...	3	515
,, Alternate day tapping ...	,, ,, ...	2	530
,, Every third day	,, ,, ...	1	502
½ Spiral Daily tapping ...	,, ,, ...	2	341
,, Alternate day tapping...	,, ,, ...	2	331
,, Every third day ..	,, ,, ...	—	350
Full Spiral Daily tapping ...	,, ,, ...	15	536
,, Alternate day tapping	,, ,, ...	12	517
,, Every third day ...	,, ,, ...	5	538
¼ Cut Daily tapping	End of Dec., 1919 ...	5	510
,, Alternate day tapping ...	,, ,, ...	2	528
,, Every third day ...	,, ,, ...	2	500
½ Spiral Daily tapping ...	,, ,, ...	8	333
,, Alternate day tapping ...	,, ,, ...	3	328
,, Every third day ...	,, ,, ...	1	349
Full Spiral Daily tapping ...	,, ,, ...	102	434
,, Alternative day tapping	,, ,, ...	34	483
,, Every third day ...	,, ,, ...	24	513

The above results undoubtedly confirm those obtained by Rands, though it does not support his statement that " this experiment, nevertheless furnishes striking evidence on the relation of the *number of cuts* to the development of Brown Bast." It is evident, that a single cut of extreme length will give similar results to a number of shorter cuts. The Malayan experiments appeared to show many interesting relationships and were continued and extended to endeavour to obtain substantial experimental proof in several directions. These it is hoped will form the subject of a future publication.

Relation of above to developing Immune trees.

An important aspect of Rand's work was the endeavour to interpret his results along the lines of obtaining trees of *Hevea brasiliensis* immune to Brown Bast. He showed in his experiments that, in a general way, high yielding trees seemed to be most susceptible to attacks of Brown Bast—i.e. *developed Brown Bast more quickly than trees yielding less latex.** At the same time were noticed high-yielding trees which did not develop Brown Bast quickly under a severe tapping system.

Rands assumed that the resistance observed on high-yielding trees might be due to specific immunity and by applying his system of tapping it might be possible to select the resistant high-yielding trees ; breeding from these, a strain of *Hevea Brasiliensis* immune to Brown Bast might be developed. Experiments were started along these lines and trees marked from which selected seed was obtained and planted. A considerable number of years must elapse before the results can be published.

Experimental evidence adduced, in Malaya, over the last two years does not support the probability of successfully developing rubber trees immune to Brown Bast.

The following is a record of the behaviour of three neighbouring blocks of 50 trees each, two tapped ½ spiral daily, the other 7/8 spiral daily. The trees were of the same age and equally developed and there was no reason to suspect any essential difference in the final results. From previous experimental observations it was expected that the more severely tapped ⅞ spiral block would give a higher number of Brown Bast trees, than the ½ spiral blocks, but this was not the case. Twelve months tapping on the ⅞ spiral block gave only one Brown Bast tree, so that for practically 12 months this block was immune (or rather, disease-free A.S.) according to the suggestions made by Rands. The half spiral blocks showed 9 and 21 Brown Bast trees respectively. In the latter case some allowance must be made, as a three months tapping on a full spiral was made on two large blocks which later were divided into eight small blocks of about fifty trees to determine their probable behaviour under the same conditions. This half spiral block of 50 trees had seven Brown Bast trees as a result of the preliminary three months tapping. However, it must be emphasised that three months preliminary heavy tapping over large blocks gave little indication of the large differences to be expected on the smaller blocks. It might be pointed out that Rands tapping for selective work extended over only four months actual tapping time, which in view of the above, can hardly be considered a sufficiently long period.

Returning to the three experimental blocks above mentioned total rubber yields for the experimental period were kept and were as follows :-

					lbs.
½ Spiral	...	(a) Brown Bast trees	21.	...	296.06
½ ,,	...	(b) ,, ,, ,,	9.	...	312.11
⅞ ,,	...	(c) ,, ,, ,,	1.	...	348.10

* (Italics mine A. S.)

The total yield gives no dependable basis of comparison for trees were continuously going out of tapping owing to Brown Bast. The average yield per tree over the period showed.

		Brown Bast trees.		lbs per tree
(a) ½ Spiral	...	21.	...	10.22
(b) ½ ,,	...	9.	...	7.15
(c) ⅞ ,,	...	1.	...	7.58

On these results it would appear that there is little relation between yield and number of Brown Bast trees.

Between August and September 1921 however, there was a sudden increase in the number of Brown Bast trees in the ⅞ spiral plot, coincident with a similar increase in other plots tapped on various systems; after 12 months without an increase in the number of Brown Bast cases seven trees went out of tapping with Brown Bast. There was a large increase in the average monthly tree yields from this plot, coincident with the sudden increase in the number of Brown Bast cases. This increased yield has been sustained for 12 months and the plot is behaving normally as compared with seven other plots.

General conditions of growth affect the percentage development of the disease to an enormous extent in all countries, according to the results published by various investigators, and seed from trees selected for their resistance to Brown Bast may be less susceptible under one set of conditions than under others. Specific immunity is difficult to realise in view of these facts. Moreover in seed selection as so far practised on rubber plantations too little attention is given to the possibilities of the male parent influencing the results. The male characteristics are of obvious importance in any breeding work, but in selection work on rubber this point appears to be missed on occasions.

Various.-- The remainder of the Brown Bast work in Rand's publication, apart from his anatomical observations published in a separate article, is rather more general. He deals with relation of Brown Bast and some environmental factors and his general observations indicate that the most vigorous trees judged by appearance, size and cambial activity, are most liable to develop Brown Bast. These trees are often the highest yielding trees. In discussing influence of soil conditions he makes a general statement that trees on poor soil or on exposed flat ridges have a smaller amount of disease than adjacent, rich, well-drained flats. He states further that elevation through its influence on growth and yield also affects the amount of disease.

The general conclusion as stated by Rands is "Previous results are in accord with the conclusion that vigorous high-yielding trees are more liable to Brown Bast than thrifty, uncrowded ones." This has been substantiated by the Brown Bast Investigation Committee by observations made on rubber estates opened up on old tapioca soil, where the trees are of poor growth with tough cortex. Even if Brown Bast is present, its progress is slow and the area restricted in extent

After the most susceptible trees have been removed from a stand, it is probably inadvisable to thin out further on a disease basis alone. This is because a high-yielding, not too susceptible tree will probably produce more in the long run than a low-yielding, more resistant type tapped continuously. The thinning out problem will be easier if we follow the advice of Hamaker and others who advocate making the new plantings dense in order to be able later to thin out on a basis of yield and disease. The most susceptible and otherwise undesirable individuals are thus eliminated without disturbing greatly the space arrangement of the remainder of the trees."

The thinning-out advice given above may be sound for Java and Sumatra, but the writer disagrees with the above suggestions if applied to Malayan plantations.

Prevention of Brown Bast.

Rands considers the question of Brown Bast prevention and his observation led him to state "A high percentage of Brown Bast was usually directly traceable to the use of a tapping system with one cut above the other tapped daily" and says further "From the standpoint of Brown Bast there seems sufficient reason to condemn the use of superimposed cuts." As far as the minutes of the Brown Bast Investigation Committee go there is no substantiating evidences for Malaya; there is no doubt that Malayan estates using other systems have had a high percentage of Brown Bast. Our experimental observations however indicate that it is not a question of any special systems of tapping, but that under any given combination of conditions a certain definite limit is set with regard to quantity of latex extracted, below which only a small percentage number of Brown Bast cases is to be anticipated. Once this limit is passed, the increase in the percentage number of Brown Bast cases is very sudden and out of all proportion to the extra amount of latex extracted.*

Rands discusses the question of Daily and Alternate Day tapping with reference to Brown Bast prevention. His general observations show a decided inclination in favour of Alternate Day tapping, which is in accordance with Malayan observations. Rands states that no thoroughly controlled tapping experiments comparing alternate with daily systems have as yet been carried out for a sufficient length of time to decide the relative merits as regards yield but a series is now being carried out on the estates in Java in co-operation with the West Java Experiment Station. The figures given in our tables indicate the large difference between Daily and Alternate Day tapping as regards Brown Bast development when a heavy tapping system is used. These figures are not meant to show any crucial difference upon which we can base advice with reference to the tapping system to be adopted, for further experiments suggest significance in directions other than the obvious, and extended observations are necessary before drawing probable conclusions.

*** This is supported by further analysis. Substantial evidence is now in hand to show that when drastic tapping is in operation, the relationship shown by yield figures obtained by estate routine tapping systems no longer holds between comparisons of Daily Tapping, Alternate Day Tapping and Every Third Day tapping on similar lengths of cut.**

Treatment of Brown Bast.

Brown Bast treatment is not dealt with in detail by Rands. He calls attention to the different methods advocated by different experts. These are the well known (1) Stripping (2) Deep scraping (3) Light-scraping, with hot tar method. In a review of this discription it is unnecessary to go into details regarding methods well established but two points of interest might be noted for the benefit of Malayan Planters. Stripping is suggested in Malaya as offering the best results and is strongly recommended by Sanderson and Sutcliffe, a note of warning has already been sounded by the Brown Bast Investigation Committee with regard to where Mouldy Rot is prevalent in areas where Brown Bast is being treated by stripping. The greatest care is necessary in these areas, for the Mouldy Rot fungus attacks carelessly protected stripped surfaces very rapidly.

Histological and Historical.

It may be of interest to consider the history of Brown Bast disease before dealing with the investigations relating to the morbid anatomy of the tissues attacked. The realisation of Brown Bast disease forms a notable illustration of the confusion which arises as a result of empirical generalisations based on insufficient experimental work.

Petch in 1910 was the first to suggest *Phytophthora faberi* (Maub) as the fungus causing a Canker of the bark of *Hevea brasiliensis* (1). This was confirmed by Rutgers (2) in Java whose extended observations practically included all known Bark affections at the time: very different symptoms were considered as different manifestations of the attacks of a single fungus i.e. *Phytophthora faberi* (Maub). It has been pointed out elsewhere (3) by the writer and others that Rutgers's claims to have established his conclusions cannot be accepted.

However, in 1913, Rutgers paid a visit to the Federated Malay States and pointed out "Barred trees" as illustrating the fact that *Phytophthora faberi* was active in the country, a statement which the writer and other mycologists working in the Federated Malay States strenuously denied, for innumerable attempts at isolation had been made without success. He reiterated his conviction (4) during a discussion on a joint paper contributed to the Batavia Conference in 1914 by Brooks and the writer. In view of his dogmatic attitude it might be expected that conclusive proofs would be forthcoming but it would appear that field observations formed the basis for his conclusions.

(1). Petch T: Cacao and Hevea Canker. Circs, and Agricultural Journal of the Royal Botanic Gardens, Ceylon Volume 5 No. 13 November, 1910

(2). Rutgers A.A.L, and Dammormann K.W.: Diseases of Hevea brasiliensis in Java: Med Van het Labratorium Von Pflanzenziekton No. 10. p 27-33, 1914.

(3). Sharples. A. Belgrave W N.C, Norris F. de la Mare and Ellis A G.G. Black Stripe and Mouldy Rot of Hevea brasiliensis Bull. No 31 Department of Agriculture, Federated Malay States, 1920

(4). Report of the International Rubber Congress and Exhibiton. Batavia. 19th to 23rd October. 1914

Time again has shown in this case, how vital is the necessity for reservation of opinion in the matter of plant disease problems when no absolute evidence has been adduced upon which definite conclusions can be based. With regard to the "A." "B." "C." and "D." forms of Bark Canker recognised by Rutgers in 1914 as all caused by *Phytophthera faberi* the position in Malaya to-day is:—

"A" form produced by a *Phytophthora* sp. related to the *Phytophthora* sp. from Burma (*P. Meadii*).

"B" form i.e. (Claret Coloured Bark Canker) produced by a *Phytophthora* sp.* different from the species causing Black Stripe in Malaya. According to Petch the fungus causing Claret Coloured Bark Canker in Ceylon is *Phytophthora faberi.* (Maub).

"C" form probably comprised in Brown Bast.

"D" (Burrs) form:—following on a Brown Bast attack.

Thus there are at least three different diseases produced by different causes, and the confusion surrounding the cause of the varied symptoms described by Rutgers could not have arisen had sufficient attention been given to fundamental principles. Petch (1) points out that a suggestion by Rands (loc cit) that the confusion between the various bark diseases arose in Ceylon could not be substantiated by facts, a statement obviously to the point when the literature is studied.

The formation of Burrs, now recognised as a feature of Brown Bast, has claimed much attention from an anatomical standpoint during the last 8 - 10 years. Up to 1917 when the intensive study of Brown Bast was commenced, most investigators had accepted Bateson's (2) and later Bryce's (3), work which confirmed Bateson's. Those authors, made careful studies of Burred tissues, without associating those growths with any specific disease, and considered that the primary stimulus which resulted in the initiation of Burrs usually arose as a result of the latex coagulating after escape from broken latex vessels. Bateson made one important statement which recent study has confirmed, that "exhaustive tapping favours the development of "Burrs." The writer cannot agree that this statement made as a result of field observations on ten trees standing in the Government Experimental Plantation, Kuala Lumpur, entitles Bateson to the claim

* Vide minutes of Brown Bast Investigation Commitee and Successful isolations and inoculations by Mr. R M. Richards.

(1). Petch.T: – Archief Voor Rubber Culture. Aug. 1921.

(2) Batesen. F: -Burr Formation:—A preliminary Note: Agricultural Bulletin Federated Malay States. July 1913.

(3). Bryce C:—Bulletin No. 28. Department of Agriculture Ceylon, October 1916.

(4). Sanderson R. A and Sutcliffe H:—"Brown Bast, an investigation into its Causes and Method of Treatment" Rubber Growers Association 38 Eastcheap, London, E.C 3.

made by Sanderson and Sutcliffe that he was the first investigator of Brown Bast to suggest a physiological origin of the disease. Bateson saw the results of exhaustive tapping in 1914 but Brown Bast as such, was not conceived till towards 1917.

Bryce (loc cit) dealt fully with the abnormal anatomical developments known as Burrs. Sanderson and Sutcliffe (1) have lately followed similar lines to Bateson (loc cit) and Bryce (loc cit) and their work was summed up by Farmer and Horne (loc cit) as follow:— "They had shown that "Burrs" result from the inclusion of areas of diseased laticiferous tissue in stone cell pockets formed by the activities of wound cambiums." Bryce in a letter to Nature (15th Sept. 1921) points out that the features observed by Sanderson and Sutcliffe have long been known but that the above statement is at variance with the results obtained by workers in the East generally. From the writer's point of view the anatomical investigations dealing with Burred tissue which are after effects easily observed, will not lead us far in elucidating the cause of Brown Bast, and it is difficult to see how Sanderson and Sutcliffe could claim to put forward a new physiological theory when their work was based on Burred tissue examinations.

Much attention has been directed to Farmer and Horne's (loc cit) work in England on preserved specimens sent from the Middle East. In early stages of the disease they showed abnormal changes occuring in the sieve-tubes the important conducting elements in the bark. Any interference with the conducting system is obviously serious, and it may be that this is the first direct effect when Brown Bast sets in.

A recent view has been expressed by experienced authorities (1) that the sieve-tubes in some cases, are not the all-important channels for conducting food materials from the leaves. Ringing experiments were carried out by the officers of this Department in 1917, on *Hevea Brasiliensis*, and the trees, ringed deeply to the wood, are still healthy, though there has been no bridging of the ring by callus ingrowths. So it is possible that the sieve-tubes in *Hevea* may be comparatively unimportant as regards conduction.

Further anatomical investigations continued over three years show many peculiarities in sieve-tube changes, even in healthy trees. Lignification or necrosis of sieve-tubes has been observed in perfectly healthy plants: the last few months have been spent examining bark from trees which have not been tapped for 5 years, none of these trees having suffered previously from Brown Bast. Our results up to date show that a large percentage of these trees have lignified sieve-tubes. It would appear from our work that too much importance has been assigned to Farmer and Horne's observations, which we hope to deal with in detail in a future publication.

(1), Dixon H H. & Ball. N G. Transport of Organic substances in plants Letter to Nature No. 2730 Vol. 109 February 23rd 1922.

SUMMARY.

Many other papers have appeared, dealing primarily with the histology of Brown Bast tissues i.e. the microscopic reaction of the tissues attacked by Brown Bast to various reagents. These are of little importance to the planter and need not be considered further in this article The important points to be noted in relation to the future policy on rubber plantations are :--

(1) The balance of evidence is overwhelmingly in favour of Brown Bast being a non-transmissible disease of physiological origin.

(2) That heavy tapping on well grown plantations raises the percentage development of Brown Bast enormously.

(3) That under a heavy tapping system, i.e. usually much heavier than is adopted in estate practice, as in the Full Spiral, Alternate day tapping shows a much lower percentage development of Brown Bast than daily tapping on the same system.

These broad facts must be considered in relation to future policy in Malaya. This would make the present article much too long if taken in detail, but a brief statement can be made now.

Much interest has been aroused during the last two years by statements and predictions regarding possible yields on rubber plantations in years to come as a result of selection, bud-grafting etc. Two thousand lbs. per acre has been suggested as a possibility from 40 trees per acre. The statement that " Good yielders always remain good yielders " has been much emphasised and that good yielders can be selected by counting the number of latex rings. A recent paper (1) shows that no significant corrolation exists between yield and number of latex rings, so that this method of ensuring the selection of the best yielders for which much has been claimed, can be considered of doubtful utility. Selection by a careful estimate of yields, which is a long and tedious process, is the only sure basis of differentiating between good and bad yielders over the period during which the estimates are taken In general it may be true that " Good yielders remain good yielders " but all investigators working on *Hevea brasiliensis* know that there are exceptions and when individual trees are considered, good yielders may become normal yielders or even poor yielders and vice versa. The writer has had several cases under observation and is of the opinion that the exceptions are probably more numerous than the supporters of the " Good yielders " idea may admit; further they might be of great significance and require careful consideration before a dogmatic statement is made.

In the recent paper by La Rue above mentioned (loc cit) he says that Dr Rands has unpublished data, showing " that type of bark structure may change with changed conditions, so that the same tree

(1) Rue C.d.La:--Structure and yield in Hevea brasiliensis Archief Von Rubber Culture: 5e Jaargang No. 12 .Dec 1921.

may change from one type to another," and there is little doubt that such changes will result in large variations in amount of latex obtained.

The following question is for the future. Will the cumulative growth conditions, i.e. type of soil, atmospheric humidity etc. etc. function, in co-operation with Brown Bast, as a limiting factor, setting a fairly definite limit to the amount of latex to be obtained from any rubber producing area? In the absence of high yielding trees resistant or immune to Brown Bast, this question is of the utmost practical importance and until evidence for or against has been gathered, an open mind is advisable. Loose statements as to greatly increased yield in the future are to be strongly deprecated; they may be interesting from a speculative point of view but progress will only be made by an arduous collection of facts and figures from which true deductions can be made.

ADDENDUM.

The review was written up several months ago. In the interim an interesting article by Keuchenius has come to notice, giving details of his Sumatran experiments. This paper will be fully considered in the light of experimental work carried on in Malaya during the last three years, as soon as our experiments can be conveniently written up. The writer is preparing a preliminary report for early publication indicating the issue of the above mentioned experiments.

Department of Agriculture, F.M.S. & S.S.

PRICE LIST.

Economic and Non-economic Planting Material.

FRUIT SEEDLINGS.

Avocado Pear (Persea gratissima).
Blimbing (Averrhoa Bilimbi).
Bullock's heart (Anona reticulata).
Carambola (Averrhoa Carambola).
Chiku (Achras Sapota).
Durian (Durio zibethinus).
Guava (Psidium Guajava).
Jack fruit (Artocarpus integrifolia).
Jambu bol (Eugenia malaccensis). Red Malay apple.
Lemon (Citrus Limonum).
Lime (Citrus acida).
Manggis hutan (Garcinia Hombroniana).
Mangosteen (Garcinia Mangostana).
Monkey Jack (Artocarpus rigida).
Orange (Citrus Aurantium).
Pomelo (Citrus decumana).
Rambai (Baccaurea Motleyana).
Rambutan (Nephelium lappaceum).
Soursop (Anona muricata).
Sugar-apple, Custard-apple (Anona squamosa).
Water Lemon (Passiflora laurifolia).

Numbers up to 100 seedlings	20 cents each.
Numbers up to 500 and more than 100 ...	15 cents each.
Larger orders	10 cents each.

Grafted plants, when available, will be quoted separately.

COVER CROPS.

Cassia mimosoides	seed	$1 per lb.
Canavalia ensiformis	,,	30 cents per lb.
Centrosema Plumieri (Butterfly Pea)	,,	14 ,, ,, ,,
Clitoria cajanifolia	,,	50 ,, ,, ,,
Crotalaria striata	,,	50 ,, ,, ,,
Dolichos Hosei (Sarawak Bean)	cuttings	$1 per sack.
Leucaena glauca	seed	50 cents per lb.
Mimosa invisa (Giant mimosa)	,,	50 ,, ,, ,,
Mucuna sp.	,,	50 ,, ,, ,,
Phaseolus lunatus (Lima Bean)	,,	50 ,, ,, ,,
Tephrosia candida	,,	50 ,, ,, ,,
Tephrosia Hookeriana	,,	50 ,, ,, ,,
Tephrosia purpurea	,,	50 ,, ,, ,,

GRASSES.

Australian Blue Couch (Digitaria didactyla)	$1 per bag of plants.
Bermuda (Cynodon Dactylon)	$1 per bag of plants.
Citronella (Andropogan Nardus)	$2 per 1,000 plants.
Guinea grass (Panicum maximum)	$2 ,, 1,000 ,,
Lemon (Andropogan citratus)	$2 ,, 1,000 ,,

GRASSES—*contd.*

Love grass (Andropogon aciculatus)	$1 per bag of plants,
Natal Red Top grass	$1 ,, ,, ,, ,,
Paspalum dilatatum	$1 ,, ,, ,, ,,

Seed, when available, 10 cents per oz.

EUROPEAN VEGETABLE SEEDS.

Large seeded varieties *e.g.*, beans	15 cents per oz.
Others	30 ,, ,, ,,
Small Packets	10 ,, each.

FIBRES.

Bimlipatam Jute (Hibiscus Cannabinus)	seed $1 per lb.
Kapok (Eriodendron anfractuosum)	seed 20 cents per lb.
Manila hemp (Musa textilis)	suckers 10 cents each.
Mauritius hemp (Furcraea gigantea)	bulbils $1 per 100
Mauritius hemp (Furcraea gigantea)	young plants $3 per 100
Roselle (Hibiscus Sabdariffa var. altissima)	seed $3 per lb.
Sisal hemp (Agave rigida var. sisalana)	bulbils $1 per 100
Sisal hemp (Agave rigida var. sisalana)	young plants $3 per 100

MISCELLANEOUS ECONOMIC PLANTS.

Arrowroot	tubers 20 cents per lb.
African Oil Palm (Elaeis guineensis)	seed $10 per 1,000
African Oil Palm (Elaeis guineensis)	seedlings $20 per 100
Bixa Orellana	seed $1 per lb.
Coffee (Robusta and Liberian)	seed 50 cents per lb.
Coffee (Robusta and Liberian)	plants $2 per 100
Ipecacuanha (Psychotria Ipecacuanha)	cuttings 10 cents each,
Jerusalem artichoke (Helianthus tuberosus)	tubers 20 cents per lb.
Patchouli (Pogostemon Patchouli)	cuttings $3 per 1,030
Sweet potato (Ipomoea Batatas)	cuttings $1 per 100
Tuba Root (Derris elliptica)	cuttings $2 per 100

NON-ECONOMIC PLANTS.

Flowering trees	seedlings from 10 to 50 cts each.
Flowering trees	seed 10 cents a packet
Shade trees	seedlings from 10 to 50 cts. each.
Shade trees	seed 10 cents a packet.
Shrubs	rooted cuttings 10 cts. each.
Shrubs	unrooted cuttings 5 cts. each.
Climbers	rooted cuttings 10 cts. each.
Climbers	seed 10 cts. a packet.
Showy annuals	seed 10 cents a packet.
Palms	seedlings from 20 to 50 cents each.
Palms	seed prices on application.
Ferns	cuttings 10 to 25 cts. each.
Bulbs	10 cents each.
Standards	20 to 50 cents each.

The above prices are quoted for material when available. Planting material of other agricultural or horticultural plants will be quoted, on application, when avaliable.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of June, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bul.	Hygrometer. Vapour Tension	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	142.21	83.1	91.00	74.6	16.23	77.8	.836	74.2	74%	...	13.47	2.71
Pahang, Kuala Lipis	...	...	81.2	90.6	71.5	19.1	76.4	...	...	...	...	4.89	1.38
Johore, Johore Bahru	...	...	...	87.55	73.33	...	...	...	...	...	...	6.01	1.74
Singapore, Kandang Kerbau	...	...	81.8	81.4	78.4	...	77.6	.915	...	84.	Cal.	4.99	3.46
Malacca, Durian Daun	...	126.	83.	88.	74.	14.	78.	.915	...	82.	N.W.	7.99	1.92
Negri Sembilan, Seremban	...	156.	79.9	87.9	75.9	12.	76.1	.818	73.4	81.	N.E.	4.48	1.69
„ Kuala Pilah	...	149.7	82.	89.9	71.8	18.1	78.5	.905	76.3	83.1	...	3.18	1.69
„ Port Dickson	...	150.7	83.	88.6	74.9	13.7	78.3	.881	75.5	78.	...	4.11	1.10
Selangor, Kuala Lumpur	...	151.1	82.4	89.7	73.6	16.1	77.4	.846	74.2	76.	S.E.	5.31	2.51
„ Klang	...	...	82.1	86.9	75.1	11.8	77.6	...	...	...	...	3.53	1.78
„ Kuala Selangor	...	...	...	90.3	70.1	20.2	...	...	...	...	...	2.41	1.60
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Telok Anson	...	...	82.83	92.	70.	22.	76.18	.813	...	73.	...	1.25	.48
„ Ipoh	...	...	83.03	96.	71.	25.	67.80	.862	78.11	77.	...	6.96	3.18
„ Taiping	...	...	82.62	94.	70.	24.	77.46	.900	...	87.	...	5.94	2.63
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	19.52	4.84
„ Parit Buntar	...	...	83.51	92.	73.	19.	78.78	.918	...	81.	...	2.87	.74
Penang, George Town	...	152.	83.9	92.	68.	24.	79.2	.928	72.4	80.5	N.W.	9.25	4.07
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	7.03	1.74
Perlis, Kangar	...	...	...	89.46	74.13	15.33	...	...	...	...	...	4.37	1.22

THE

Malayan Agricultural Journal.

Vol. X. JULY, 1922. No. 7.

EDITORIAL.

TAPPING EXPERIMENTS WITH BUD-GRAFTED RUBBER.

THE widespread interest shown in bud-grafting makes Dr. Vischer's article in the November number of the Archief v.d. Rubbercultuur on "Tapping experements with bud-grafted rubber" of uncommon importance. So many diverse rumours have been in circulation that a clear and candid presentation of the facts ascertained up to the present is extremely welcome. Grafting was performed from October 1917—January 1918, bud-wood being taken from five mother trees, four of which were abnormally high yielders. Results are given for average daily yields over 7 months tapping from plots of 84 to 123 trees.

MOTHER TREES:

The mother trees were planted in 1907-8 and gave the following daily average in grams dry rubber (4 grs. per day = approx. 3.1 lbs. per year of 350 tapping days).

		1916.	1917.	1918.	1919.	1920.	1921.
P W. 34	...	26.0	37.3	45.3	43.7	25	(brown bast)
" 225	...	43.0	48.6	56.2	65.0	37	(" ")
" 2	...	37	45.	49	59	27 23	(" ")
" 217	...	47	47	b.b.			
" X		Unknown ?					

LATEX RINGS WERE.

Height at which measured.		1919. 1.60 M.	1919. 5 M.	1922. 1.60 M.	1922. 5 M.
P.W. 34	...	52	27	53	32
" 2	...	38		50	28
" 225	...	28	24	45	24
" 217	...	45	42	65	48
" X	...	?	?		

Dr. Vischer points out the surprising fact that all four known mother trees developed brown bast; it is impossible to decide whether this denotes susceptibility or was due to weakening of the tree brought about by removal of branches for use as bud-wood. He further notes that P.W. 34 with the highest number of latex rings was the poorest yielder, while P.W. 225 was exactly the reverse.

Tables are given showing a high correlation between circumference and numbers of latex-vessel rings—these are summarised as follows:—

OFFSPRING:

P.W. 34 Av. circumference. 37.62 cms. $\pm$ 9.0. Rings 8.76 $\pm$ 4.8
Coefficient of correlation 0.781 $\pm$ .008

P.W. 2 „ 34.82 $\pm$ 8.9 7.77 $\pm$ 2.88
„ „ „ 0.682 $\pm$ .069

P.W. 225 „ 38.94 $\pm$ 10.5 $\pm$ 2.0
„ „ „ 6.74 0.3 $\pm$ .056

P.W. 217 Group (i) „ „ „ 0.88 $\pm$ .012

„ „ (ii) „ „ „ 0.655 $\pm$ .18

These correlation coefficients are all high compared with that found by La Rue for plants grown from seed which was 0.162. Dr. Vischer considers from these figures that two definite types—many and few latex rings—may be separated, and that the relationship of rings to circumference is a congenital (inner) character which is passed on from the mother tree to the scions.

Table V gives average production per tree per day in grams *wet* creped latex rubber, for three of the bud-grafted plots, tapped on ½ daily.

	P.W. 34	P.W. 225	P.W. 2
May	9.1	7.0	6.6
June	8.8	5.0	5.5
July	9.1 (7.5)	4.0 (2.4)	5.1 (4.4)
August	7.0	1.7	3.5
September	6.1	8.0	5.0
October 1—4	9.6	3.6	5.0
October 11—31	7.0	4.5	4.4

The figures in brackets for July are weights of *dry* rubber. On October 5th all were put on a new tapping cut at 1M. high on ½—no records are therefore given for October 5—10th.

Table VI gives individual production figures for *dry* rubber during July—

P.W. 34	98 trees	Av. yield = 7.54 gr.	Stand. deviation ± 2.5
2	84	4.4	± 1.8
225	123	2.4	± 1.2
217 (i)	96	3.4	± 1.7
(ii)	87	6.4	± 1.8

It is pointed out that the observed variation within each group in much smaller than that in seed plants a number of which at 6 years had a daily average of 8.3 gr. with a standard deviation of ± 5.4.

Table VII gives yields in grams of *dry* rubber per day of seed stock planted March 1916. 36 trees tapped on ⅓.

1920.		1921.		1922.	
April	1.9	Jan.-July not tapped.		January	5.8
May	2.5	August	5.4	February	5.2
June	2.6	September	4.7	March	4.8
July	2.8	October	4.5	April	6.2
August	2.6	November	6.0	May	6.7
September	3.1	December	5.0	June	6.9
October	3.5			July	6.5
				August	5.7

Dr. Vischer is careful to point out that no final conclusions can be drawn from the figures given. It is impossible to predict the effect of future tapping from analogies with seed stock and comparison with seed stock plants of exactly similar age was impossible. The fairest comparison is probably with the yields of August-December 1921 given in Table VII.

Further the months on which the bud-grafts were tapped included the wintering months. Wintering is very much more uniform in the case of bud-grafts of the same parentage, than in a mixed seedling population.

Dr. Vischer points out the necessity of vigorously continuing the selection work in Java.

These most interesting records contain but cold comfort for those who consider yields of 1—2 tons per acre to be within their grasp in say — five years time, and give point to the warnings given both in the Handbook of Malayan Agriculture[1] and the Malayan Agricultural Journal[2], that bud grafting is still in the experimental stage. It is a necessary and invaluable experiment, but — an experiment.

(1) Malayan Agriculture, Handbook compiled by the Department of Agriculture, F.M.S. & S.S. 1922. Pages 54 & 64.

(2) M.A.J. Vol. X, No. 4, April, 1922, p. 112.

The outstanding facts are :—

1. All the carefully selected high yielding mother trees developed brown bast. While the removal of branches may have brought about the attacks, our statement that "high yielders are to be regarded with suspicion" appears to hold good outside Malaya.

2. Although all the grafts from a single mother tree show a marked similarity in yield to each other, they *do not necessarily resemble their parent,* and may in fact be all very poor yielders.

3. So far as comparison can be made, only one of four abnormally high yielders gave bud-grafts which had definitely a higher yield than plants from seedling stock (which does not appear to have been from selected seed), while one gave about half the yield.

It is useless to labour these points — further work is obviously required before budgrafting can be regarded as a success. As it stands at present an estate with large areas planted from a small number of selected mother trees might find—

1. All susceptible to brown bast.

2. Considerable numbers definitely and *uniformly* below the average of seed stock plants of similar ages.

It is of course possible that future work will bring to light a quick method of finding mother trees which are immune to brown bast and which "bud true," but the time is not yet. At present one generation must be allowed to mature and be tapped to settle the second point.

In the end it may be found that the average plant, like the average man, has the finest staying power, and it is staying power which is wanted on a plantation.

BUD SELECTION IN "HEVEA."

By H. W. Jack.

THE budding of "Hevea" seedlings is now practiced on many estates and while, theoretically, it is fairly safe to assume that some slight improvement in yield of latex will result, there is a decided tendency, in the writer's opinion, to expect far too great an improvement so that these few notes may serve a useful purpose in warning planters against too sanguine expectations. While there is no intention of discouraging experiments in the various methods of budding, these notes are intended to indicate some reasons why public anticipations of fabulous yields of rubber per acre are likely to prove disappointing. In the selection of trees for use as budwood, assuming that only robust, healthy trees of good yielding ability are used, the resulting plantation of buddings should undoubtedly be some improvement over the plantation which contained the parent bud stock, provided that environmental conditions in the daughter plantation are similar to those in the parental area. This improvement is simply due to the elimination of obviously poor and defective individuals in the process of selecting trees and is likely to be restricted to agricultural characters, the yield of latex showing no proportionate increase, for it is widely known that there is no relationship between yield of rubber and the appearance of the tree.

Let us consider the methods adopted for selecting parent trees. The first essential is the health of the tree as determined by thorough external examination. Apparent healthiness does not, however indicate immunity to disease because absence of disease is often merely due to the absence of sources of infection and a change of environment may synchronise with the proximity of disease resulting in infection to the detriment of the offspring of the selected healthy tree.

Secondly, trees are selected by counts of the number of latex rings contained in the barks on the assumption that bark having many latex rings will yield a proportionate amount of latex. This method is not practical as far as the average planter is concerned, and there is as yet no adequate proof that buds from trees selected by this method will produce trees showing an equal or even similar number of latex rings. Moreover, the coefficient of correlation between the number of latex rings in the bark of a tree and its actual yielding ability, as calculated from several series of figures, has been found to vary from near zero up to round about 0.5 only. These extremes of coefficient are of no significence—they merely indicate that, at the best, the chances of a correlation between the characters in question, are even.

In the third place, trees are selected by actual yield comparisons by taking periodic records of yield either by volume of latex or weight of dry rubber, over a variable length of time, usually not less than a

complete annual cycle. This method is certainly the best but has its imperfections, for invariably little or no account is taken of the environment of the tree, its inherent constitution or the tapping error of the coolie.

Under the term environment, probably the most vital considerations are those of soil texture and water supply, both factors of admittedly great importance to the economy of the tree, yet budwood from selected parents trees is often railed hundreds of miles to different parts of the country or even to another country and the resulting plantation of buddings is expected to show similar characters and to produce latex at the same rate as the parent tree. With regard to the inherent constitution of the selected parent tree usually nothing whatever is known and no recognition is taken of the problems of variation to which buddings may be liable, for, as far as "hevea" is concerned, little is yet known as to whether propagation by budding really does provide a progeny having the same characteristics as the parent, a doubt which is emphasied by the fact that most buddings are grown on a foreign root stock. Shamel, a noted American authority on bud variations divided them into two classes (i) those which are not inherited, and (ii) those which are inherited, and in the first class he includes all variations which are due to environmental influences.

Now, in selecting a parent tree by comparison of actual yield records it is impossible to form any definite opinion as to whether its yielding ability is an inherent character of the tree or whether it is merely a fluctuating variation dependent on environmental influences. If the tree comes under the latter category, then its use as budwood for the establishment of a budded plantation under conditions even slightly dissimilar would be of little avail and experience shows that chemical and more particularly physical conditions vary considerably even over very short distances on the same area of land.

Again, under this method of selection the coolie error of tapping, which, as is well known, is a very material one, is usually neglected. The number of rings of latex vessels in the bark increases rapidly in each successive millimetre working inwards to the cambium and this accounts largely for the large variation in yield of latex from the same tree if tapped by different tappers whose skill is guaged by the depth of bark which they can excise without causing damage to the cambial layer.

Although vegetative propagation has been extensively practiced with many plant forms in the last few decades there appear to be no results with any crop really comparable to "Hevea." Quinine (*cinchona sp.*) is the nearest approach. Working with several species of this crop for nearly forty years, a crop increase has been effected by Dutch workers in Java by propagating vegetatively only those plants showing a high alkaloid content in the bark combined with good growth characters but little improvement of the best types originally introduced into that country has resulted.

If the results of vegetative propagation, as applied to fruit trees, are considered, it is found that though a high degree of crop improvement is attained yet the inherent characters of varieties show no such amelioration, in other words there is no improvement of the race. The Victoria plum, for instance, though it has been grown true to type by buddings for many years yet when propagated from seed immediatedly gives rise to innumerable different forms having characters varying widely from those of the parent plant. As another example of the failure of bud selection to achieve any improvement of the race, reference may be made to sugarcane. Countless attempts have been made in several countries to propagate vegetatively plants of a particular variety showing a specially high content of sugar but not a single attempt has yet been succesful. In contrast to this failure, beet plants when selected for high sugar production and propagated by seed, gave rise to progeny which showed similar high sugar contents, within the limits of fluctuating variation. Also experiments which have been made with "cacao" in Trinidad to compare the results of the propagation of good plants by seeds and by vegetative methods, show that plants grown from seed yield more heavily than budded or grafted plants derived from the same parent trees.

The vegetative propagation of notably good tea plants has also been tried for many years but all such efforts have long since been abandoned in favour of seed propagation.

With "Hevea" there is as yet no known morphological character which can be definitely correlated with yield of rubber and until some such character can be found all vegetative propagation is of the nature of an experiment of which the issue can only be determined by the lapse of time. Dutch research workers lead the way in the question of vegetative propagation of this plant but even in Java, no conclusive records are yet available to show that budded plants are superior to plants raised from seed, though there is some evidence that the process of eliminating obviously poor trees in the selection of parent plants has a beneficial effect on the progeny of the latter.

It is hoped that these notes may help planters to realise that, though the art of budding is now mastered, the practice of budding is still in the experimental stage and should therefore only be adopted on estates with due caution and with reserved anticipations of its results.

The study of methods of vegetative propagation of "Hevea" other than by budding might prove useful in the interval, while waiting for definite proof regarding the efficacy of budding.

A PRELIMINRAY ACCOUNT OF OBSERVATIONS ON THE FUNGI CAUSING "BROWN ROOT" DISEASE.

A. SHARPLES.

BUTLER[1] says under the heading of "*Brown Root disease (Hymenochaetae noxia Berk).*"

"This is one of the diseases formerly included under the general name "Stump Rot," since it ordinary arises, like the diseases caused by Rosellinia and Ustulina from the decaying stump of some jungle or shade tree, which has been cut down and left to rot in the soil in which the tea is growing. It is widely distributed in the tropics, occuring in Ceylon, the Malay Peninsula, Java, Sumatra, New Guinea, Samoa, and East and West Africa. It attacks a number of the most valuable tropical products and also jungle trees; rubber (Hevea, Manihot, Castilloa, Funtumia) coffee, cacao, camphor, breadfruit, Caravonica, cotton, coca, dadap (*Erythrina sp.*), *Grevillea robusta, Cinnamomum Cassia, Albizzia stipulata,* and *Brunfelsia americana,* being amongst its victims. It is the commonest root disease of rubber in Ceylon, and the only one known to attack cacao in that colony. In India, it has, so far, been noticed on tea, coffee, Hevea, Manihot, and Grevillea only, but will probably be found on other hosts."

Petch[2] describes the symptoms on rubber *(Hevea brasiliensis)* as follows :—"It was first recorded on *Hevea* in Ceylon and it is probably the commonest root disease of the Rubber tree in that country ....Brown Root disease spreads very slowly.................consequently it only infects the neighbouring trees when their roots are in contact with those of the diseased tree and the progress of the fungus is so slow that, as a rule, the first affected tree is dead before the neighbouring trees are attacked. In general, therefore, only one tree is killed at each centre of infection, unless the dead tree is left standing for a long period."

"When the dead tree is dug up the special characters of Brown Root disease are usually immediately obvious and as a rule, there can be no mistake in the diagnosis. The roots are encrusted with a mass of sand, earth and small stones to a thickness of three of four millimetres; this mass is fastened to the root by the mycelium of the fungus and consequently cannot be washed off. The mycelium consists of tawny brown threads which are collected here and there into small sheets or loose masses, either on the surface or embedded in the crust of soil and stones. The colour of the mycelium varies and one frequently finds brownish-white, or almost white masses intermingled with the tawny brown. In the early stages the predominating colour of the mycelium is brown, and this is usually the case, when the roots of a dead tree are examined. Hence the name Brown

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1 Butler. E. J.---Fungi and disease in plants. 1918 p. 429.

2 Petch, T.---The diseases and pests of the Rubber tree. 1921 p. 41.

Root disease. But when the fungus has been established for a long time, and has grown older, it forms a black, brittle continuous covering over the brown masses of hyphae, and the diseased root then appears chiefly black. The brown mycelium is, however, immediately discernible if the black crust is cut."

"*In all cases, the encrusting mass of earth and stones, intermingled with brown threads serves to distinguish this disease.*"

"The diseased wood usually shows characteristic markings, though these may be of two entirely different types. In one case the wood is soft and friable, with a network of fine brown lines and even with a hand-lens it can be seen that these lines are composed of brown hyphae. Thin sheets of brown hyphae run through the decaying wood, and these appear as brown lines when the wood is cut. This is the more frequent appearance in the lateral roots. In the other case the wood of the root is comparatively hard, and traversed by rather broad, brown bands in which no hyphae are discernible. This may occur in the lateral roots, but is more usual at the base of the stem. There is some evidence that the appearance first described follows the second. In either case the wood in an advanced stage of decay may be honeycombed, the brown plates persisting after the tissue between them has almost completely decayed."

The above extracts were, in a general way, applicable to our knowledge of "Brown Root" disease on *Hevea brasiliensis* in Malaya. Up to 1920, no special attention was necessary, and this disease was comparatively scarce. In that year during the progress of thinning-out operations on a Malayan estate, cases of Brown Root disease on old trees were so numerous as to call for special attention.

In this preliminary article it is unnecessary to go into detail. The diagnosis in the above cases was Brown Root disease, the typical encrusting mass of earth and stones being prominent in all cases. On splitting the lateral roots, the wood was much harder than in healthy roots and split with prominent, usually transverse corrugations. Brown lines in the diseased tissue were not prominent, though occasionally present.

As a good supply of material was available, isolations were attempted and pure cultures obtained. The causative fungus had previous to 1917 been referred to *Hymenochaetae noxia* (Berk) but during 1917, Petch obtained numerous fructifications of *Fomes Lamoensis*-(Murr) from Tea and Hevea plants killed by Brown Root disease. He says (loc. cit), "These show that the fungus is really a *Fomes* and that the brown patches hitherto observed, the supposed *Hymenochaetae* are merely abortive attempts to produce the *Fomes* sporophore." This statement without support by work on pure culture lines could not be considered conclusive, so attempts to study pure cultures were undertaken in order to gain positive evidence.

Pure cultures on rubber wood blocks were obtained from the diseased Hevea roots mentioned above. A check was made by

obtaining pure cultures of the fungus causing Brown Root disease on Camphor (*Cinnamomum camphora*) a large patch of which had been slowly dying out for years owing to Brown Root disease in the Experimental Gardens, Kuala Lumpur. The cultures were so distinct that it was scarcely possible they could be one and the same fungus. This immediately raised the possibility of many different fungi able, when attacking roots of different tropical crops, to produce similar symptoms, the latter being classed under the general heading of Brown Root disease.

This possibility was tested further by getting typical Brown Root disease specimens of Rubber roots sent from Ceylon. These were in good condition and successful cultures established. This again resulted in a fungus obviously different from the preceding two.

Details of distinguishing features in the cultures may be left for a further publication. In every feature they were easily distinguishable, yet they had one peculiarity in common, *the secretion of mucilage by the hyphae when in contact with water.* When grown on wood blocks in Roux tubes, the hyphae penetrate through the cotton wool pad separating the culture block from the water, aggregate on the surface and after a few weeks, a large mucilaginous mass is visible in the water, attached to the hyphae. There can be little doubt that this production of mucilage in contact with water is the explanation of the typical symptoms presented in Brown Root disease the secretion of mucilage causing the binding together of the encrusting mass of earth and stones.

There are then three different morphological fungi associated with Brown Root disease which physiologically, are comparable. The question now to be answered is, Whether it is not possible that the symptoms characterising Brown Root disease on its varied hosts are produced by just as many different fungi morphologically, but similar in a physiological sense in that they all possess hypha capable of secreting mucilage on contact with water? The evidence obtained during the investigation supports an affirmative reply.

The Camphor Brown Root fungus and the Ceylon Brown Root fungus are well separated by their cultural characteristics, though in their final stages they show characters considered typical of the genus *Hymenochaetae.* The Malayan Brown Root appears to be forming fructifications much resembling those of a typical *Corticium.*

A final detailed publication with illustrations will be issued in due course.

MOTHS FROM COCONUT SPIKES.

By G. H. Corbett.

IN continuation of the preliminary note on the "Lesser" Coconut Spike Moth published in The Malayan Agricultural Journal, Vol. X, No. 5, the four species of moths bred from coconut spikes have been identified by Mr. E. Meyrick as follows :—

Tirathaba sp. near *trichogramma*, Meyr. "Greater" Coconut spike moth.

Erecthias flavistriata, Wals.

Pyroderces ptilodelta, Meyr.

Batrachedra arenosella, Walk. "Lesser" Coconut Spike Moth.

The three former were obtained from opened spikes showing considerably decay.

Dr. Guy. A. K. Marshall, Director of the Imperial Bureau of Entomology, in his letter forwarding the above identifications stated in reply to an enquiry for information, that he was unable to ascertain that anything has been previously recorded with regard to the habits or life history of *Batrachedra arenosella*.

Mr. Bainbridge Fletcher in his "Life Histories of Indian Insects, Microlepidoptera" published in the Memoirs of the Department of Agriculture in India, Vol. (VI), Nos. 1 - 9 states "originally described from New Zealand, this widely distributed species is now known to occur also in Tasmania, Queensland, New South Wales, South Australia, and British Guiana. Within our limits it has been recorded from Maskeliya, Coorg, Bangalore, Calcutta, and the Khasi Hills. We have it from Pusa" and quotes from Pr. Linn, Soc. N.S.W. XXII, 302--303 (1897) "Larva amongst seeds of *Juncus*, joining them together with a slight web. Pupa very slender in a cocoon amongst the seeds."

Rao Sahib V. Ramachandra Rao in "A Preliminary list of Insect Pests of Mesopotamia" published in the Report of the Proceedings of the Fourth Entomological Meeting held at Pusa in 1921, referring to the Date palm states that "The most serious pest of the Date palm in Mesopotamia is the "Hashaf" Moth ; young fruits are bored into by a small caterpillar, whereby they turn red, dry up, and drop down ultimately. The loss according to Buxton may be as much as 50 per cent. Buxton refers to his pest as a Gelechiad but he did not rear the moth. Specimens of moths reared and brought here (Pusa) with me are pronounced by the Imperial Entomologist to belong to the Family Cosmopterygidae."*

*** The Editor, Mr. Bainbridge Fletcher, of the above publication in a foot note on page 168 records. "Since identified as *Batrachedra amydraula*, Meyr "**

It has yet to be decided if the damage caused by the caterpillars of *Batrachedra arenosella* to the male and female flowers of the coconut spikes before opening is so serious as *Batrachedra amydraula* on the young fruits of the Date palm, but the female flowers of coconut spikes examined show a greater percentage of direct injury.

DESICCATED SHREDDED COCONUT AND OTHER COCONUT PRODUCTS.

By B. J. Eaton.

An enquiry has been received recently from the Malay States Information Agency regarding the production of desiccated coconut in Malaya, owing to the fact that several produce merchants have approached the Agency on the subject.

Desiccated shredded coconut is an article of export from Ceylon and there is no reason why this product, together with other preparations of fresh coconuts, should not be prepared locally for export.

In America the three principal products on the market are:

(1) Fresh grated coconut canned in its own milk or water;

(2) Moist sweetened coconut without the milk in cans;

(3) Dried shredded coconut prepared with sugar in cardboard packages.

Manufacture.—The manufacture of the first two of these products might be taken up by the pineapple canning factories in Malaya, since these firms already possess the necessary machinery for the manufacture of the tins or cans from imported tin-plate and also the necessary plant for sterilization.

The manufacture of dried shredded coconut might also be undertaken in similar factories since it would, in the writer's opinion, be necessary to export dried shredded coconut in tins rather than in cardboard packages. This product however could be exported in large tins, so that if necessary, smaller cardboard packages could be prepared by wholesale dealers in the importing countries.

In experiments carried out by the writer about three years ago, it was found that desiccated coconut, dried to a moisture content of about 5 per cent., rapidly absorbed moisture in this climate and became very rancid, so that this product requires to be stored locally and exported in sealed tins. It would probably not be desirable to add boric acid or other preservative, in the case of this product, which is used as a foodstuff or for confectionery purposes. The addition of sugar and/or salt would probably prevent the development of the rancidity.

The local pineapple canning factories have two seasons, during which the factories are fully occupied in the canning of pineapples. These seasons coincide with the two principal fruiting seasons of the pineapple. During the remaining months, work at these factories is slack and most of the labour is discharged, so that the canning of coconut products could probably be undertaken particularly during these months and the labour retained.

Further enquiries are being made in this connection with the object of endeavouring to start a local industry for the export of these products.

Preparation of Products.—In the preparation of the dried shredded product, the skin or testa of the copra would have to be removed first by hand or mechanical peeling and the "meat" shredded by machinery and dried in vacuum ovens or in hot air chambers. A mechanical drier, such as a hot chamber through which endless band conveyors, on which the shredded material is spread in thin layers, are passed, would be suitable. Such a drier is in operation on one estate in Malaya.

In the preparation of shredded coconut preserved in its own milk or water the material would be preferably heated to a temperature below the boiling point of water before being placed in the tins and then subjected to a higher temperature for a short time after sealing the tins.

Moist sweetened coconut could be canned by placing the meat in a sugar solution as in the case of pineapples, and sterilizing the product in the tins by heating.

PREPARATION OF DESICCATED SHREDDED COCONUT.

The following details of preparation of desiccated shredded coconut should be of value to prospective manufacturers.

Husking.—The husk is removed by bringing the nut down forcibly on a spike fixed upright in the ground. The spike pierces the nut which is given a twist by the coolie and removed. A coolie can husk 200 nuts per hour. This is the common method of husking practised in Malaya.

Removal of Shell.—In order to leave the kernel whole, the shell has to be removed carefully. The husked nut is taken to a small circular saw which is provided with a concave guard to fit an averaged sized nut. The saw projects beyond the guard an amount equal to somewhat less than the thickness of the shell, so that it is unable to penetrate the kernel. The shell is cut all round in quarters and about 220 nuts can be treated per hour. The nut is then broken by means of a spear hammer without damaging the kernel. A coolie can treat about 110 nuts per hour.

Removal of Skin or Testa.—The brown skin or testa is then removed by means of a shaped spoke shave and the kernel is pierced to allow the "milk" to escape. A coolie can roughly clean about 110 nuts per hour. Any particle of brown skin left after the preliminary treatment is removed by another coolie.

Cutting and Shredding.—The nut is then removed to a cutter or shredder depending on whether chips or shreds are required.

For the manufacture of chips a machine containing a disc revolving in a hopper is employed, to which knives are fitted on the side.

For the manufacture of desiccated shredded coconut the nuts are fed into a machine containing numerous small circular saws—say 20 of about 8 inches diameter—spaced about 3/8 inches apart. The hopper into which the nuts are fed has a horizontal reciprocating motion of about 1½ inches, which together with the ratio of speed of the saws makes longer or shorter shreds as required.

Drying or Desiccation.—The material is now ready for drying and this is carried out in a chamber with forced draught at a temperature of 160°—190°Fah. When dry the material is ready for packing.

Packing.—The product is usually packed like tea in lead-lined cases or lead packets.

Bye-Products.—Rejected nuts are used for the preparation of oil, as are also the parings and tailings from the factory.

Anderson Oil Expellers are used for first pressing, followed by hydraulic expressers for second pressing to obtain the maximum of oil. In the case of local companies manufacturing desiccated coconut products only, the waste material could probably be sold to local oil mills. The husk, not used for fibre manufacture, can be used as fuel for heating the driers. The shell can also be used as fuel for a similar purpose or converted into charcoal.

FACTORY AND MACHINERY REQUIRED FOR MANUFACTURE OF DESICCATED COCONUT

The following details have been supplied by a firm which manufactures machinery for the preparation of desiccated coconuts:

	£	s.	d.
Grating Machine.—Improved coconut grating machine (output 10-15 cwt. per day) price ..	97	13	0
Drying Plant.—Chula drying machine ...	250	0	0
Sifting Machine.—Sifting machine ...	112	0	0

Remarks on Factory and Machinery.—A good light airy factory is required with a cement floor and a good supply of fresh water.

The nuts should be husked outside the factory to avoid contamination with fibre and dust. The shells can be removed outside the factory or at one end and the kernel peeled inside the factory.

A cement trough containing clean water is advisable, so that the kernels can be washed after peeling to remove more readily any particles of skin (testa) or dirt.

The grating machine designed by the firm mentioned is based on the description of the shredding method described above. The peeled kernel is placed in the hopper of the machine on an adjustable guide through which fine pitch revolving circular saws protrude, which grate the kernel clean.

The machine can be adjusted to give varying proportions of fine and coarse material. A hand machine is also made by this firm, but no price has been quoted.

Drying Plant.—The shredded material is spread on light steel trays with galvanised steel wire gauze bottoms which are placed on runners in the drying chamber.

The hot air is drawn over each row of trays by means of a fan provided. The shredded material should be spread in a thin layer on the trays and the finer grades can be dried in about ½ hour at 190° Fah., but a lower temperature (160°Fah.) is recommended and a drying period of about 1½ hours for each charge.

The dried material should be allowed to cool off before being sifted and packed. A drier capable of an output of 100 lbs. per hour is quoted at £176, while the larger machine quoted at £250 has an output of 200 lbs. per hour. The driers required 1 and 1½ H.P. respectively for running.

Sifting Machines.—The sifting machine, which consists of coarse and fine oscillating screens or sieves, separates the dried shredded product into three grades, the coarsest material being delivered at the top, while the medium and fine material passes through the coarse sieve and is separated by the second sieve below, which only passes the finest material. The machine only requires about ½ H.P. for operation.

The total power required therefore for a small factory for one grating, drying and sifting machine is about 5-6 H.P.

A small grinding machine and the sifting machine could be worked easily by hand.

Market Prices.—Recent quotations in London for desiccated coconut are as follows :—(April 1922).

Fine	40/ per cwt.
Medium	40/6 ,, ,,
Coarse	43/ ,, ,,
Chips and threads	60/ ,, ,,

The fine, medium and coarse grades are the three grades obtained on the sifting machine previously described. No recent information is available as to the prices of the other tinned products, but in 1920, in America, tins containing 4 ozs. of coconut preserved in 6 ozs. of coconut water sold at 11 cents gold per tin.

Addendum.—The following additional information in respect of marketing of and machinery for desiccated coconut has been received since the above article was written.

A produce merchant in England states that the present price is 40 shillings per cwt. ex-store London or Liverpool, packed in 130 lb. cases. He recommends however that the product be packed in 56 lb. and 100 lbs. cases, with an extra charge of 1 shilling for 56 lb. boxes. He also states that a very large business is done in Manchester at the present time.

Quotations have also been received for another type of dryer—the "Express" Dryer—costing 2,350 francs ex-works, Paris, exclusive of packing.

This dryer has a capacity of about 57 lbs. of shredded coconut and experiments have shown that the moisture content can be reduced from about 41.5 per cent. to 5.5 per cent, in 3-4 hours.

A large continuous dryer of a similar type is also constructed, in which the grated coconut can be delivered from the grating machine on to conveyors in the dryer. No price has been quoted for this type.

The Secretary for Agriculture will be glad to receive enquiries from any firms who are interested in the manufacture of these products and to answer any questions, as far as possible. (Reference D.A. 916/22 should be quoted by enquirers).

CASTOR OIL SEEDS.

NOTES ON OIL CONTENT AND EXTRACTION OF OIL.

By C. D. V. Georgi.

DURING the past year a large number of experiments has been carried out on the determination of the oil content of various varieties of this seed grown locally, and also on the extraction of the oil, and as some useful data have been collected it has been decided to summarise and publish the results.

Seed.

The two common varieties found in this country are the large white bean with brown flecks, usually referred to as the Kedah variety, and the small mottled dark brown seed which is more widely distributed. A medium sized bean with curious light brown markings has also been found but, as this was probably a variety resulting from a cross of the large and small, it calls for no special comment; such a variety would be produced where plants from the large and small seeds were growing side by side.

Storage of Seed.

Unless the seed is being pressed soon after collection care must be taken to ensure that it is kept dry, since, if allowed to become moist, the seed will heat and ferment with a resultant increase in the acidity of the expressed oil.

As an example of this the following case may be quoted:—A large quantity of seed was kept for some months without particular attention being paid to storage conditions, and when the oil was expressed the acidity, calculated as oleic acid was found to be approximately 13 per cent.

Oil Content.

There is little difference between the oil content of the various seeds, when calculated on the whole seed, as the following results, (Table I) taken from recent analyses show, the variation in all cases being within the limits found in the case of natural products.

It may be mentioned that the average yield of about 40 per cent. is somewhat lower than that found in other countries, for example India, where this crop is cultivated. The oil content from the best varieties grown in India is between 45 and 50 per cent.

It is curious to note that the oil content of the two medium sized varieties is the highest.

TABLE I.

	Large variety.			Medium variety.		Small variety.	
	No. 1	No. 2	No. 3	No. 4*	No. 5	No. 6	No. 7
Number of seeds per ounce ...	40	38	45	82	91	215	216
Proportion of Husk, per cent. ...	23.3	21.7	24.9	25.2	25.1	29.7	30.2
Proportion of Kernel, per cent. ...	76.7	78.3	75.1	74.8	74.9	70.3	69.8
ANALYSIS OF WHOLE SEED.							
Moisture, per cent. ...	7.6	7.2	8.6	6.5	7.7	7.6	7.3
Oil Content,† per cent.	41.6	37.3	37.9	44.9	48.3	40.7	36.8
Residue, per cent. ...	50.8	55.5	53.5	48.6	44.0	51.7	55.9
Oil content calculated on dry seed, per cent.	45.0	40.2	41.5	48.0	52.3	44.0	39.7

EXTRACTION OF OIL.

The treatment of castor seed differs from that of other oil seeds owing to the soft non-fibrous nature of the kernels and, although decorticated seed produces oil of paler colour (cold drawn oil from decorticated seed has been obtained practically colourless), this operation is not usually carried out. The soft non-fibrous nature of the kernel renders the satisfactory expression of the oil from decorticated seed difficult, especially if the seeds are fresh; some fibrous material must be added to act as a binder.

Further the seed is not usually ground before pressing, as the soft kernel makes such an operation difficult and the active enzyme (lipase) which is present also renders rapidity of working desirable. The seed is therefore merely warmed to about 50°C. (120°F) before pressing in order to render the heavy viscous oil more mobile.

On account of the comparatively high viscosity of the oil, even at the increased temperature, it is necessary to employ high pressures to obtain the maximum yield. Frequently seed is pressed twice, once cold, then heated and pressed again. Pressures of between 4,000 to 6,000 lbs. per sq. inch are usually employed, while in America mills are being constructed to work up to pressures of 8,000 lbs. per sq. inch.

* Variety imported from Rhodesia and grown for the first time.
† Extracted with Chloroform.

Castor seed has also been successfully treated in Anderson Oil Expellers (See Agricultural Bulletin Vol. VII, No. 1, January and February 1919) but in this case low pressures must be used as high pressures cause overheating of the oil with discolouration and contamination with meal.

With efficient pressing about 30 to 33 per cent. of oil should be obtained leaving about 10 to 12 per cent. in the cake, which can only be recovered by a solvent extraction process. Such a process would however only be employed where the quantity of castor seed being pressed was sufficient to warrant the installation of the necessary plant.

Castor Oil.

Excluding cold drawn oil, which is used for medicinal purposes and the further treatment of which is a somewhat specialised process, castor oil extracted by either of the methods quoted above is generally suitable for industrial purposes without further treatment. The colour varies from a pale greenish brown to dark brown tint, while the acidity, calculated as oleic acid, is from 2 to 4 per cent. The small amount of albuminous matter in suspension in the oil can if necessary always be separated by blowing steam through the oil. This causes the albuminous matter to coagulate: the precipitate can then be removed either by sedimentation or by passing through a filter press.

Castor Cake.

On account of the presence of the poisonous principle ricin, castor oil cake cannot be used as a feeding stuff, but on account of its high nitrogen content it is a good fertiliser. The average nitrogen content of meal containing between 12 and 15 per cent. of oil averages between 4.2 and 4.8 per cent., which corresponds to between 5.5 and 6.5 per cent. on the dry, oil-free cake.

The presence of excess of oil in the cake besides acting as a diluent also retards its decomposition when applied as a fertiliser, thus lowering its value. The decomposition may not be retarded sufficiently however to affect its value in the case of permanent crops, but with those of short duration the fertilising value would certainly not be so great as with an oil-free cake or one with a low oil content.

OIL EXPELLERS.

By B. J. Eaton.

WITH reference to the previous articles in the Agricultural Bulletin Vol. VII, No. 1, January—February 1919, pages 1--14, and the Malayan Agricultural Journal, Vol, X, No. 5, May 1922, a reduced quotation for the Smulders' Expellers has been received recently and details are given below:—

Heated Distribution Kettle	... 215	Guilders.
Expeller Type B. ...	... 7,125	,,
Spare parts ...	... 810	,,
Interchangeable parts for seeds other than copra ...	... 1,970	,,

The interchangeable parts render the Expellers suitable for the treatment of linseed, cotton seed, mustard seed, kapok seed, ground nuts, and other small seeds and consist of the following parts:—

One Quillworm No. 136.

One threaded spacing collar No. 138 with bronze ring No. 151.

Two discharge worms No. 135.

Two worm spacing collars No. 122.

,, ,, ,, ,, No. 137.

One complete presschamber without clamping bars.

One pulley to drive quill worm No. 237.

The makers state that this Expeller can treat about 440 lbs. of copra per hour; the capacity for other oil seeds is decreased according to the nature of the seed. The Expeller is also used for castor seed but, for this seed, oil presses usually give better yields. (Ref. D. A. 899/22).

WORK OF THE INSPECTION STAFF (April 1st—June 30th, 1922).

By F. W. South.

STAFF.

THE services of all the Special Field Officers in Ulu Selangor were terminated during the Quarter, as it is hoped that Pink Disease in the District has now been got under control so thoroughly as to enable the normal Staff of the Department to maintain such control efficiently and at considerably less expense than was involved in providing three European Officers for this district.

Estate Visits.

One hundred and seventy-nine visits were paid to estates by the Agricultural Inspectors in various parts of the country during the quarter, the majority either as part of routine inspection work, or to advise about treatment of pests or diseases.

Diseases and Pests of Rubber.

Pink Diseases (Corticium Salmonicolor).—This disease was newly reported from eight estates in Selangor, two in Pahang, two in Negri Sembilan and fifteen in Johore.

In Perak North there were bad attacks in Selama sub-district around Selama and Batu Kurau.

In Selangor there was a marked reduction of the prevalence of this disease in Ulu Selangor District owing to the good work of the Special Field Officers in Tanjong Malim and Ulu Yam. The disease continued its spread, reported during the first quarter, westerly and south westerly from the Sungei Buloh forest reserve. This area has received careful attention from the Assistant Agricultural Inspector, Selangor. The outbreak at Batang Berjuntai died out during the quarter.

In Negri Sembilan there were bad attacks in a few areas, the country around Bahau will receive special attention.

In Johore the Inspector of Agricultural found the disease in a number of cases on 10 year old trees of the worst of the badly grown South Johore type. This attack was new to the Inspector and appears somewhat unusual, since the poor foliage on such trees usually allows the entry of sufficient sunlight to prevent infection.

Penang, Malacca and Singapore were free from the disease. In all other centres the position regarding it was as usual and calls for no comment.

Mouldy Rot, (*Sphaeronema fimbriatum.*)—In Negri Sembilan the rainfall increased in all districts during the quarter and in consequence the disease reappeared in Jelebu district and in the Chuah mukim of Port Dickson district; it became more prevalent, especially on overgrown holdings, in all the other infected areas, and in Kuala Pilah district a few new holdings near Juasseh became infected. Efforts to enforce treatment have been maintained successfully by the Special Field Officers and the Assistant Agricultural Inspector, except in Rembau district where the work has been neglected on account of padi planting.

Painting with disinfectants is now usual, but it is most difficult to stop tapping or to induce owners to change the position of the tapping cut after treatment. A point of interest in regard to many Malay holdings is that they are worked by the Chinese on a profit sharing basis. This practice causes a difficulty in treating Mouldy Rot, as the tappers are not liable in a court action and therefore continue to work the holdings irrespective of the presence of the disease. To overcome this difficulty the Special Field Officer in Seremban district has had personally to supervise the work on most of these holdings.

In Malacca the disease reappeared on the previously infected estate near Alor Gajah on 17th May this reappearance was attended to personally by the Assistant Agricultural Inspector, and the disease has been confined to a very small area by the usual preventive measures.

In Johore Mouldy Rot was newly reported from 5 estates. The disease is spreading. Several properties including two Estates, have been found to contain infected trees at Tampoi, in South Johore. The rate of spread has been rapid on one estate in Northern Johore. There is no rapid spread of this disease in small holdings, but neither is there any diminution in the number infected. The fines imposed by some Magistates act as no deterrent for neglect and make it scarcely worth while bringing cases to Court.

In the opinion of the writer the reason for the frequent reappearance of the disease on previously infected rubber trees even after an interval of 6 or 9 months during which the fungus has been quiescent, requires further investigation to find if possible, a form of treatment that will completely destroy the fungus.

Black Stripe (*Phytophthora sp.*)—This was newly reported from 1 Estate in Selangor and 1 in Johore. Some very severe cases were found on the estate in Selangor; otherwise Selangor was fairly free from the disease during the quarter, owing to comparatively dry weather.

A few cases were noted on a Chinese owned Estate at Jelebu in Negri Sembilan, but action was taken and the spread of the fungus appears to have been arrested.

Pod Disease.—Two isolated cases of this have been noted by the Assistant Agricultural Inspector, Penang and Province Wellesley.

Root Disease. (Fomes lignosus.)—The Assistant Agricultural Inspector, Perak North was requested to visit new clearings on one estate where a heavy cover of *Centrosema plumieri* was reputed to be assisting in the spread of the disease. Investigation showed clearly that the cover crop and the debris of decaying vegetation beneath it formed a suitable medium for the growth of the fungus. Other cover crops such as *Tephrosia candida* when planted on young clearings covered with timber also serve to assist the spread of *Fomes lignosus.*

Wet Rot. (Fomes pseudoferreus).—The prevalence of this disease on old rubber especially in Negri Sembilan, to which attention was called in my previous report, was well shewn during this quarter when high winds and rain storms prevailed; on many trees that fell the exposed roots showed the characteristic symptoms.

Black Line. (Ustulina zonata.)—Fork and branch cases of this disease are reported to be common in North Johore as also are collar cases. In Selangor also fork and branch cases are not rare. The ill effects of delay in removing decaying timber were shown by the number of cases of this disease combined with *Fomes lignosus* and *F. pseudoferreus* on an estate visited by the Chief Agricultural Inspector in Perak.

Brown Root disease.—This was found to be prevalent combined with *Fomes lignosus* and *Ustulina zonata* on an estate in Northern Johore. Many trees blown over showed all three fungi occasionally with Wet Rot and white ants in addition.

The routine work of enforcing the control of prevalent diseases such as Pink Disease and Mouldy Rot was rendered less effective owing to the fact that the power to authorise court proceedings, originally vested in the Director of Agriculture and automatically cancelled when the appointment was abolished, could not be conferred on the Secretary for Agriculture until special Amendment Bills passed the Legislative and Federal Councils in June.

COCONUT PESTS AND DISEASES.

Beetles (Oryctes rhinoceros) and *(Rhychophorus Sach).*—The routine work of destroying the breeding grounds of these beetles has been regularly sustained everywhere and good progress has been made in the more seriously infected areas recorded in my report for the last quarter, especially Penang and Province Wellesley, Lower Perak, Kuala Selangor and Klang districts. In Malacca coconut beetles are now only occasionally found, while the Assistant Agricultural Inspector, Selangor, reports that at Port Swettenham a few trees are now bearing fruit for the first time for three or four years. Coconut beetles, probably the black beetle, have been found by the Junior Agricultural Assistant, Ulu Selangor, breeding in the stumps of a jungle palm known to the Malays as Bayas.

Plesispa reichii.—Numerous young palms on a holding near Rasa station in Ulu Selangor were found to be attacked by this beetle.

The Assistant Agricultural Inspector, Negri Sembilan, records the presence of Aphis, scale insects and skipper caterpillars on certain coconut palms, but none of the insects were doing serious damage.

PADI PESTS AND DISEASES.

Stem Borers.—These insects (species not given) did some damage in two localities in Selangor where the owners neglected to burn the old stubble after harvesting. Otherwise the padi in Selangor is so far comparatively free from pests.

Army worms (Species not specified.) A few isolated cases of attacks of what were probably these insects are recorded on nursery beds in the Kuala Pilah and Rembau districts of Negri Sembilan.

Rats. These did considerable damage in one area in Kuantan district. The area is comparatively large, but only a portion was being cultivated, with the result that it was difficult to find and destroy the breeding places of the rats in the undergrowth surrounding the padi. Traps gave the best results in destroying the animals.

The Department has distributed to outstations a supply of barium carbonate which is a cheap and effective poison for rats. Its use is being explained to planters of padi and the District Officers in several districts have been supplied with an account of the methods of preparing poisoned baits.

No other reports of pests have been received as in many parts of the country padi planting has not yet commenced.

LALANG AND BLUKAR.

There is little to report under this heading. The general policy as regards infested holdings remains unchanged, since owners of rubber land cannot afford to clear their land in most cases. The expected results are now becoming evident generally and lalang is very prevalent all over the country.

WATER HYACINTH.

The gang of coolies in Perak North worked in various parts of Krian until the beginning of June. After this they worked for twelve days around Taiping and on June 19th proceeded to the Perak River and were at work near Parit at the end of the quarter.

In Perak South four coolies are working in a small tributary of the Perak River—the Sungei Sireh, as the weed was plentiful there and caused obstruction to estate drains.

In Pahang East a patch of Water Hyacinth on State land near Kuantan is to be removed.

Owners have been required to remove this pest from their land around Taiping; in small areas in Selangor; and in remote places in Negri Sembilan.

It will be seen that in the Federated Malay States work is being continued steadily. In the Colony the drains are cleared periodically of scattered patches of the weed by the Public Works Department, but no other action is taken, as little if any harm is done. In Johore the destruction of Water Hyacinth is in the hands of the Assistant Advisers and District Officers.

PESTS AND DISEASE OF OTHER CROPS.

Pests of Roselle.—Mealy bugs did some damage to roselle on an estate in Perak South. Cotton Stainers (*Dysdercus sp.*) are recorded to have attacked it near Kuantan but to have been controlled by a nicotine spray. These stainers are also recorded on cotton in Negri Sembilan. They are present on plants of the genus Hibiscus all over the Peninsula and are becoming commoner. Scale insects including *Lecanium nigrum* are recorded on Roselle and Hibiscus plants in Malacca and aphids have been found causing a leaf curl on Roselle in Malacca: emulsions were used successfully to check the scale insects.

Pests of Citrus.—White fly and an unidentified beetle were found on citrus in Pahang East. Scale and aphis are recorded from Negri Sembilan. Scale insects and a large brown bug were found commonly on young citrus plants in Malacca. An internal caterpillar was found in pomelos in Negri Sembilan and is common in this fruit generally. it is under investigation by the Entmologist.

Banana Slippers (Erionoto Thrar).—These were common in Selangor and Nergi Sembilan, but did little damage.

Miscellaneous Pests.—Grasshoppers have been prevalent on various hosts in Negri Sembilan and scale insects and aphis have been found on various fruit trees Specimens of many of these pests have been forwarded to the Government Entomologist who has supplied reports on them, and when necessary, taken steps to have them identified. Special attention is being given to pests and disease of general crops in order to ascertain which may prove serious if any crop is cultivated on a large scale.

Die back of Durians is recorded from a locality near Batu Gajah.

Stem Disease of Rambutans.—An interesting fungus disease on the bark of the stems and main branches of Rambutans and probably also of Pulasans was noticed in some old dusuns of the Lubok Salak path near Tanjong Malim. The fungus always associated with the disease forms large fruiting bodies at first yellow then brown on the surface of the infected parts. It appears to be an Ascomycete.

Pink Disease has occurred on Fruit trees and other cultivated plants and shrubs in Ulu Selangor all such alternative hosts are being carefully recorded.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of July, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	139.68	82.4	90.61	74.90	15.70	76.4	.796	72.4	72	...	2.73	0.87
Pahang, Kuala Lipis	...	...	81.8	90.4	71.4	18.9	77.0	...	...	...	...	3.29	1.85
Johore, Johore Bahru	...	...	...	87.62	73.83	13.79	...	...	...	...	...	4.12	1.50
Singapore, Kandang Kerbau	...	...	83.	84.9	78.1	6.1	78.	.926	...	80	S.E.	3.38	1.51
Malacca, Durian Daun	...	127.	83.	88.	74.	14.	78.	.913	...	81.	N.W.	3.97	1.02
Negri Sembilan, Seremban	...	152.1	79.6	87.7	73.6	14.1	75.3	.807	73.5	80.9	N.E.	4.55	1.53
,, Kuala Pilah	...	146.7	80.9	88.5	70.8	17.7	77.6	.878	75.4	84.2	...	4.01	1.22
,, Port Dickson	...	154.6	82.2	87.6	74.6	13.	77.9	.872	75.3	79.5	...	7.37	2.63
Selangor, Kuala Lumpur	...	150.5	81.7	89.7	72.3	17.4	76.9	.837	73.5	77.	N.W.	4.10	1.46
,, Klang	...	...	80.8	86.4	74.6	11.8	76.3	...	...	...	...	4.17	1.21
,, Kuala Selangor	...	...	...	89.8	70.0	19.8	...	...	...	...	...	3.03	1.29
,, Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Telok Anson	...	...	82.63	92.	70.	22.	77.32	.868	...	79.	...	2.20	.74
,, Ipoh	...	...	83.06	94.	70.	24.	76.63	.832	74.43	75.	...	3.62	1.10
,, Taiping	...	...	83.33	94.	71.	23.	77.16	.850	...	75.	...	6.14	2.20
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	7.16	1.25
,, Parit Buntar	...	...	83.27	92.	70.	22.	77.85	.882	...	79.	...	1.14	.39
Penang, George Town	...	154.	82.2	92.	70.	22.	79.	.948	72.3	86.6	S.	6.81	2.08
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	8.35	2.75
Perlis, Kangar	...	...	...	88.06	74.61	13.45	...	...	...	...	...	6.15	1.45

THE

Malayan Agricultural Journal.

Vol. X. August, 1922. No. 8.

EDITORIAL.

IN this number of the Journal will be found a valuable report on roselle fibre cultivation from the pen of Mr. G. E. Henning, Manager of Sweet Kamiri Estate, Sungei Siput, Perak. The subject matter of this article embraces the experience gained on Sweet Kamiri Estate in the cultivation of roselle, from the initial experimental stage of eighteen months ago to the present day when, as Mr. Henning proves, he is able to produce and market roselle at a profit. Buyers of roselle invariably enquire what quantity of fibre can be marketed; they state, they are not prepared to consider the purchase of this commodity in small quantities, but wish rather for consignments running into thousands of tons per annum. The experience of Sweet Kamiri Estate now proves the possible success of this industry: and our thanks are due to the Manager of the Estate for making public the results of his experience, which it is hoped may be of practical utility to others who are planting roselle.

The Department of Agriculture with the help of its Advisory Committee is doing its utmost in suitable cases to bring planters in different parts of the country who are trying, or interested in, similar products into touch with one another, so that experience and knowledge gained may be pooled for the benefit of all. Greater combination in this respect will help all concerned by getting results more rapidly and at less cost and by putting producers in a stronger position to market their produce.

OIL FROM ALEURITES SPECIES.

By C. D. V. Georgi.

WITH reference to the article on Tung Oil or Chinese Wood Oil and Candle Nut Oil from *Aleurites spp.* in The Agricultural Bulletin, Vol. VII, No. 3, May and June, 1919, page 162 et seq., a further series of experiments with these nuts has been carried out recently.

The objects of these experiments were to ascertain the most satisfactory method of cracking the nuts, at the same time preserving the kernels whole or in large pieces, and to determine the analytical constants of the oil, since in the article referred to above there was some doubt as to the exact differences between Tung oil or Chinese Wood oil and that derived from *Aleurites* species growing in this country.

An ample supply of the nuts was kindly placed at the disposal of the Department by Mr A. M. Tuke of Kota Tampan Estate, Lenggong, Upper Perak, on whose estate the cultivation of this crop has been commenced.

The species on this estate has been identified as *Aleurites moluccana* (*syn. Aleurites triloba*) which is found widely distributed throughout this part of the world, and the oil derived from which is known as Candle nut oil.

A further sample of oil, useful for purposes of comparison, was also received from Syed Abdul Rahman, Junior Agricultural Assistant, Pekan. This sample of oil, prepared from seed collected locally, had been exhibited at the Malaya-Borneo Exhibition and awarded first prize in its class.

Experiments on Cracking.

The shell of the nut is very hard while the kernel is soft and brittle, and tends to cling to the shell, with the result that when the nut is cracked it breaks into small pieces, to each of which a portion of kernel adheres. If nuts are cracked with a hammer, the separation of the kernels can only be effected by the laborious method of picking out the separate portions with a knife or other sharp pointed instrument.

In the Philippine Islands and Hawaii, where the candle nut tree is cultivated on a commercial scale, various methods are employed by the natives to crack the nuts, all of which depend upon a method of heating followed by rapid cooling, with the object of fracturing the shell and extracting the kernel whole or in the two portions in which it appears to be divided naturally.

The methods used in the present series of experiments were those described in the Bulletin of the Imperial Institute, Vol. XVIII, No. 1, January to March 1920.

(1) The nuts were dried in the sun for several days and then cracked with a hammer.

Almost all the nuts when cracked broke into small pieces, so that the method is not satisfactory.

(2) The nuts were covered with straw which was set on fire. When the straw had burnt out, the nuts were sprinkled with cold water and cracked with a hammer.

The results of this experiment were also unsatisfactory.

(3) The nuts were boiled for five hours, allowed to dry and cracked with a hammer.

The boiling appeared to have had little effect, the kernels not being loosened to any extent inside the shell.

(4) The nuts were heated in an oven and then plunged into cold water.

This method, which has been developed by the Bureau of Science in the Philippine Islands gave the most promising results. Two variations of the method were tried.

(*a*) Heating for 2½ hours at a temperature of 105°C., plunging into cold water and allowing to soak.

Of the 100 nuts taken for the experiment 86 were found to have been cracked by the treatment or could be cracked when squeezed between the fingers, 75 kernels being in large pieces, 8 in small while 3 were bad. Of the remaining 14 nuts, 100 were cracked by tapping with a block of wood the kernels being extracted in large pieces, while only 4 were unaffected by the treatment.

(*b*) Heating for 1 hour at a temperature between 130°C to 140°C, plunging into cold water and allowing to soak.

Of the 100 nuts 63 kernels were extracted in large pieces, 2 in small, while 6 were bad. Of the remaining 29 nuts, 23 were easily cracked as in (*a*), while only 6 appeared to be unaffected.

This last method therefore appears to afford the most likely solution to the problem provided that the nuts are not exposed to a high temperature sufficiently long to affect the quality of the oil. As a matter of fact in the present experiments judging by the colour, odour and general appearance practically no difference could be seen. The oil pressed out from nuts which had been heated was brighter that than from untreated nuts, but this was probably due to the coagulation of some of the albuminous matter during the heating.

Oil Content.

The results of analysis of the nuts were as follows :—

		Present Sample.	Former Sample.
Average weight of nut	...	7.4 grams.	
Percentage of Kernel	...	32.5%	30%
,, Shell	...	67.5%	70%
Kernel.			
Moisture	...	5.1%	
Oil (Chloroform extract)	...	62.3%	60.6%
Residue (by difference)	...	32.6%	
Oil (calculated on dry kernel)	...	65.6%	
Nut.			
Oil (calculated on whole nut)	...	20.2%	18.2%
Residue.			
Nitrogen (mean of two determinations)		9.9%	

These results are in close agreement with those previously found as is shown in the above table.

The high nitrogen content of the residue would render it valuable as a fertiliser ; it cannot be used as an ingredient of feeding stuffs on account of its strong purgative action.

Expression of Oil.

The kernels, even when pressed cold, yield a considerable proportion of oil and owing to the low moisture content the oil is only very slightly contaminated with albuminous matter.

A further quantity of oil can be obtained by warming the residue and pressing again but the colour of this oil is slightly darker than the cold pressed.

An experiment was made to ascertain the proportion of oil which could be expressed in a small laboratory hand press ; —About 2 lbs. of the kernels were cold pressed, warmed and pressed a second time and the resulting cake analysed.

The results were as follows : –

Moisture	...	3.7%
Oil content	..	13.8% (14.3% on dry cake)
Residue (by difference)	...	82.5%
Nitrogen in residue	...	6.14%

Assuming, therefore, that the original kernels had an oil content of 62 per cent., it will be seen that between 75 and 80 per cent. of the oil has been expressed.

The experiment shows that with an efficient press it would be unnecessary to prolong the heating of the kernels to obtain the maximum yield of oil. Further it was noticed that the difference in colour of the warm and cold pressed oils was only very slight and the Iodine numbers also were practically identical.

Analytical Constants of the Oil.

Table 1 gives the analytical constants of the various samples of this oil.

No. 1.—Present sample of oil from Kota Tampan Estate
No. 2.—Sample of oil from Pekan.
No. 3.—Average figures for Candle nut oil given by Fryer and Weston.
No. 4.—Previous sample of oil from Kota Tampan Estate.

Table I.

——	No. 1, Present sample Kota Tampan Estate.	No. 2, Present Sample Pekan.	No. 3, Fryer and Weston Average figures.	No. 4, Previous sample Kota Tampan Estate.
Oil.				
Density at 15.5°C ...	.9293	.9237	.925	.9257
Refractive Index at 20°C ...	1.4773	1.4766	...	...
Saponification value ...	193.3	194.0	193	191.4
Iodine value (Wijs method)	149.0	148.4	164	163.1
Acidity (Oleic Acid per cent.)	2.3	2.4	...	0.4
Fatty Acids.				
Solidifying point (Titer Value)	12.5°C	11.6°C	13.0°C	...
Mean Molecular weight ...	282.4	281.0	...	...

These results show that the figures for the oil both from Kota Tampan Estate and from Pekan are in close agreement ; they also agree with the average values as given by Fryer and Weston for Candle nut oil except as regards the Iodine number which is lower by about 15 per cent. That the Iodine number of this oil varies within wide limits is shown by a further reference to the Imperial Institute communication quoted above, in which analyses of various samples of this oil from different parts of the British Empire are given.

Source of oil.		Iodine number.
Cook Islands (South Pacific)	...	158.5
Hongkong ...	...	139.7
Mauritius ...	...	151.0

It is also noteworthy that the Iodine number for the present sample of oil from Kota Tampan Estate is also less by about 15 per cent than that found for the previous sample. This lower figure is difficult to explain, it is too large to be due to any differences in experimental methods and can only be ascribed to some variability in the character of the oil.

ROSELLE FIBRE.

HIBISCUS SABDARIFFA VAR. ALTISSIMA.

By G. E. Henning.

THE factors of primary importance in the cultivation of roselle are those of climate and soil. It is urged that no success with this crop can be obtained in really dry weather, although on the other hand, excessive rain is liable to do injury by beating down the plants in their young stage. Planting should be carried out if possible at the commencement of the rainy season.

Soil.—It has not yet been determined what particular type of soil will yield the highest returns of fibre but roselle is known to thrive on loam soils which are capable of retaining a good supply of moisture, and on any other good friable soil. Laterite soils are, however, unsuitable; as is also a light soil deficient in humus. Steep hills should be avoided as Roselle has a small tap root; consequently heavy rains are liable to uproot the plants: in addition to this, the crop is more likely to be damaged by wind storms. Well drained flat land, and gently undulating ground, are suitable.

Planting.—The area to be planted, which must be thoroughly clean and free from weeds, should be changkolled, or forked, to a depth of about 4-6 inches, and after being exposed for a few days to the action of the atmosphere, any surface lumps of soil should be broken up so as to form a fairly even seed-bed. When the climatic conditions are favourable, the seed is drilled in rows about 3 inches apart and the soil lightly raked over; the rate of sowing being about 25 lbs. of seed per acre. *By planting close, one avoids side branches which break the continuity of the fibre, and thus one obtains better yields per acre, as there is considerable waste in cultivating for branch fibre. A safe estimate on this system of planting is half a ton of combed fibre, per acre. On Sweet Kamiri Estate up to 1,400 lbs. of fibre per acre from one harvest have been obtained. · The cost of upkeep after planting is practically nil as weeding is discontinued after sowing, any weeds that do appear during the early stages of growth being soon shaded out. It will be seen from this that it is very necessary to have the land free from weeds prior to sowing. On Sweet Kamiri Estate two consecutive crops have been obtained over 12 acres without material decline in yield.

Stripping and Retting.—The best time for cutting is just after the plant has flowered *i.e.* at about three months from planting. When the time comes for harvesting all fibre should be stripped from the wood in the field before retting, as this is more economical.

An effective method of stripping is to have about six pegs of hard wood fitted tightly into a good beam, say three feet long on uprights of about 4 feet in order to allow it to be fixed firmly in the ground. The method of stripping the fibre is to give the butt end of the stalk three or four sharp taps until the fibre at the butt-end is freed from the stick,—the ends being gathered in the hands; placing the fibre

round the peg and pulling, when the whole of the fibre will strip from the stick. It is important not to harvest more fibre than can be stripped on the day of cutting, otherwise the material becomes dry and it is then extremely difficult to separate the fibre from the stick. It would appear that the best time for harvesting is after rain, as the fibre comes away more easily from the stick than it does during a dry period. The retting tanks should be near a stream to facilitate the washing of the fibre after retting. Retting takes from eight to ten days. The material should be inspected on the eighth day and removed from the tank if sufficiently retted, but if not, left for another day or so until the process is complete. The cultivator is warned of the danger of over retting, which causes the fibre to be weak and brittle. A recent report by a London broker on one sample of fibre submitted indicates this danger. The broker in question stated......... " but part rather weak caused probably by being over retted." The fibre while in the tank is kept submerged in the water; this is easily done by placing heavy jungle timber over the fibre. The fibre after being removed from the tank, is thoroughly washed in running water, if possible, and care taken to see that all foreign matter is removed during the process of washing. The next operation is sundrying, after which the fibre is combed and baled, when it is ready for shipment. It is not essential to comb the material but it is to be recommended as a very much higher price is obtained.

Costs.—The following costs are based on Roselle being grown as a catch crop with a yield of half a ton per acre, per crop.

	cts.	
Tillage to a depth of six inches, harrowing sowing and other charges in bringing the crop into bearing	.65	per lb.
Cutting and Stripping	2.00	,,
Retting	2.00	,,
Baling	.10	,,
Total cost on Estate exclusive of cartage and freight, etc.	4.75	,,

i.e. $106.40 per ton.

The above figures are the actual costs on Sweet Kamiri Estate, but do not include the charges for erecting tanks or the collection of seed, as this is infinitesimal.

The freight on 1 ton of fibre from Sungei Siput to London is as follows:—

	$ c.
Rail freight Sungei Siput to Penang ...	11.52
Charges receiving, etc. rail into store ...	3.20
Insurance, premium and stamp (Insured for £35)	1.98
Steamer freight to London and stamp ...	28.00
Charges of receiving, storing, forwarding and Shipping	9.60
Bills of lading and stamp	1.50
Total ...	55.80

Making an all-in cost c.i.f. London of $162.20 or $81.10 per acre. The above figures presume effective baling at 50 cubic feet per ton, which is the allowance given by shipping Companies. The acquisition of a baler is therefore essential for economical marketing.

The reports received from London on samples of fibre submitted are distinctly encouraging. The following abstracts from reports may be cited as typical :—

(*a*) London, 29th September 21. "Material is of a jute nature but stronger. We value Samples as follows :—

A ' Sample uncombed valued about	...	£20 per ton
B ' Sample combed about	...	£30 ,,
Waste from 'B' value about	...	£15 ,,

(*b*) The value of this fibre on the 8th February was about £28 per ton as against the value of jute at £24 or so per ton, and you will remember that the Sample you supplied was not of first quality."

(*c*) 8.6.22. "The sample is of excellent colour, good length... .. it (roselle) is always in demand and present value is about £35 per ton. It should be shipped in press packed bales about 400 lbs. gunnied and roped."

The amount of combings is very small, not exceeding 2-3 per cent. of the total crop. Preliminary advice from London of the first ton shipment (Sent on 4th June) states that the firm price would be about £35 per ton.

The profit therefore amounts to $188 per ton or about 75 per cent.

In further explanation of market price, it should be pointed out that the price of jute has varied in the last year from £24-£38 per ton, the price having shewn a steady rise during the year under review.—*Straits Times.*

NOTE ON INDIAN HEMP.

THE true hemp (*Cannabis sativa*) is not grown in India for fibre. Practically the whole export of Indian hemp consists of the fibre of the Sann Hemp (*Crotalaria juncea*), though small quantities of Sisal Hemp are also exported.

Sann Hemp is, of course, a leguminous plant and like Indigo combines the advantages of a green manure with those of a revenue crop.

A special enquiry was instituted by the Department of Statistics India, in 1917, with a view to arriving at an estimate of the Indian production of hemp fibre. The total area under hemp was given as 785,300 acres with an average outturn of 667 lbs. per acre. The four chief producing provinces were Madras, Bombay and Sind, United Provinces, and Central Provinces and Berar.

The stalks of the plant when cut are soaked in water, then bruised with stones, then re-soaked and so on until the fibre strips off easily. It is only in tracts where water is plentiful that the hemp can be soaked in clean water and the fibre obtained free from mud. In tracts where water is not plentiful the stalks can only be soaked in muddy pools with the result that the dried fibre is found to be impregnated with dust.

The adulteration of Indian hemp has, for several years, been the subject of complaint from importers in the United Kingdom. The Government of India came to the conclusion that it was neither practicable or necessary to have recourse to legislation in the matter. It is understood that the present system, by which the buyer relies on the established private marks of the better known shippers to guarantee him consistent grading, works satisfactorily. In Bombay hackling or combing is already done on a fairly extensive scale and the industry has received an impetus from the improved prices obtained for combed hemps. The hackling has to be done by hand as no suitable machinery exists. The results of the combing are said to be :—

(*a*) The fibre is freed from dust.

(*b*) The fibres are evenly retted by the combs and each bundle or hawk after combing contains fibres of nearly equal length.

(*c*) The short ends of the hemp are combed out as Tow.

The total export of raw hemp from Calcutta in 1918-9 was 489,420 cwt. valued at Rs. 14,679,622. The United Kingdom is by far the biggest importer followed by the United States of America and France. The Sann Hemp exported from Calcutta is classed in the trade under three grades :

(1) Benares Sann Hemp,
(2) Green or Raigarh Hemp
(3) Bengal Sann.

Normally about 85 per cent. or 85,000 bales (350 lbs. each) is classed as Benares Sann Hemp. The bulk of the export trade is handled between October and May.

The standard qualities of each grade as exported from Calcutta are as follows:—

Sann Hemp	No. 1 No. 2 No. 3 No. 4
Green Hemp	No. 1 No. 2 No. 3 Tow
Bengal Sann	No. 1 No. 2 No. 3

Similar classifications are adopted at Bombay, where the export is about 80,000 bales of 3¾ cwt. each, and Madras.

At the time when the shortage in flax was being severely felt, the use of suitably prepared Sann hemp for flax in canvas was advocated by the Fibre Expert to the Government of Bengal. The uses of Sann hemp would extend to all the coarser articles which have hitherto been made from flax, such as hose pipes, belting and canvas.

Prior to the war the United Kingdom's requirements of hemp were mainly supplied (in order of importance) by the Philippine Islands, New Zealand, India, Russia, Italy and Germany. These imports included true hemp from Russia and Italy, Manila hemp, (*Musa textilis*) from the Philippines, Sann hemp from India, New Zealand hemp (*Phormium tenax*) from New Zealand and 'Mauritius hemp' (*Furcroea gigantea*) from Mauritius. True hemp fibre is a satisfactory substitute for flax and, except for the finer linens, is used for the medium grades of nearly all goods commonly made from flax. It is also largely used for cordage, ropes and in the manufacture of carpets and rugs. It has been pointed out that it is not unlikely that the world will look to countries like India for the supply of fibres which may be used as substitutes for the European hemp crops.

(Abstract from Supplement to the "Indian Trade Journal," May 30, 1919, D.A. 831/22).

Note.—Sann hemp has been grown quite successfully in Malaya on a small scale on undulating land.

L.L.B.

MODERN FACTORY PRACTICE IN THE PREPARATION OF PALM OIL.

INTRODUCTION.

THE following is an abstract of an important communication by Ir Jhr F. C. van Heurn, Chief chemist at the General Experiment Station of the A.V.R.O.S., entitled "Proposed arrangements for Palm oil factories." The original paper in Dutch was published in 1921 in General Series No. 10 of the publications of that institution, but an English translation was kindly placed at the disposal of the Department of Agriculture by the author.*

In view of the importance which it is hoped the African oil palm will assume as a crop in this country in the future, it has been considered advisable to abstract the report in some detail, in order that those interested may become acquainted with the latest developments regarding the production of this oil.

The report deals only with the preparation of Palm oil, that is the oil present in the pericarp or flesh of the fruit, the preparation of palm kernel oil, the oil present in the kernel, is not considered.

DEVELOPMENT OF INDUSTRIAL PREPARATION.

The industrial preparation of palm oil may be regarded from two standpoints, namely the production of a medium quality oil, containing varying proportions of free fatty acids, suitable for the manufacture of soaps, candles and lubricating greases, or an oil with the minimum quantity of free fatty acids which can be used for edible purposes.

It had been established by the Germans some years ago that palm oil of low acidity (1·2 per cent. free fatty acid) could be used not only in the manufacture of edible oils and fats, but also formed an excellent basis for the preparation of margarine or substitute butter.

This was also confirmed by the findings of the 1916 Committee on Edible Oil producing Nuts and Seeds.

> "Palm oil so improved in quality as to be edible is a distinct possibility, but is not likely to be available in large quantities for some years. If palm oil of high quality could be produced, its texture and other qualities will probably make it at least as valuable for margarine as coconut or palm kernel oils."

As regards the adoption of this oil for use in margarine little has been accomplished up to date, but, as stated in the report quoted, this is due to the fact that the quantity of such palm oil has been limited, since factories erected in the past have not been designed with the idea of producing a high quality oil.

In the case of palm oil there is one condition of paramount importance which must be fulfilled, if the manufacture of edible oil is to become a possibility, namely the necessity for dealing only with fruit which is fresh and undamaged. Fruit, which has remained too

* Compare Agricultural Bulletin Vol. IX No. 2 page 103 "The African Oil Palm in Sumatra" by J. N. Milsum.

long on the stems, or been allowed to remain on the damp ground, or stored in heaps is of no use for this purpose, since under these conditions fermentation takes place which results in the decomposition of a certain amount of the oil.

The oil present in the ripe fruits is practically neutral and experiments have shown that it is possible to extract the oil as such on an industrial scale by preliminary heating of the fruits. In the following table (Table I) the results of seven of these experiments are given, in each of which about 20 lbs. of fruit were expressed in a small hydraulic press. From these figures it will be seen that the amounts of free acid are only between 1.1 and 1.6 per cent. except in experiment No. 7 in which damaged fruit was used, when the acidity rose to 5.6 per cent.

Further it appears that the method of heating the fruits, whether in boiling water or an autoclave, is immaterial. Though it was expected that fruit heated in boiling water or steam would increase in weight by reason of absorption of water, the experiments show that the contrary is true.

Nevertheless dry heating is advised in actual practice in order to eliminate the maximum quantity of moisture.

TABLE I.

Experimental Pressings with whole Fruits.

Details of treatment and time elapsing between collection and expression.	Mode of heating.	Weight of fruits before heating.	Weight of fruits after heating.		Loss during heating.	Acidity of oil after filtration.
		lbs.	lbs.	ozs.	ozs.	per cent.
About one day ...	About five minutes in boiling water.	22	21	13	3	1.5
Do. ...	In autoclave at ½ atmosphere pressure.	22	21	14	2	1.3
Spread out for two days.	Dry in an aluminium boiler.	22	21	13	3	1.6
Do. ...	Dry in iron pan ...	22	21	11	5	1.1
Bunches with adhering fruit, loose fruits pressed after six days.	In autoclave at ½ atmosphere pressure.	20	19	14	2	1.3
Fresh fruit detached from bunch and spread out for four days.	Do. ...	22	21	14	2	1.5
Bruised fruits pressed immediately after gathering.	Do. ...	22	22	3	+3	5.6

The necessity for dealing only with fruit which is ripe and undamaged is shown by the following experiments:—About 132 lbs. of ripe fruit were divided into four portions and treated as follows:—

1. 22 lbs. spread out on a cloth over a wooden framework, all fruits separate.

2. 22 lbs. spread out in the open, imitating as far as possible fruit lying on the ground in a plantation.

3. 44 lbs. heaped up in a box.

4. 44 lbs. heaped up in a box and sprinkled with water three times a day.

After a week the four separate portions were pressed and the acidities of the resulting oils are shown in Table II below:—

TABLE II.

Ref. No.	Mode of Storage.	Acidity per cent.
1	Dry and separate	3.5
2	On the ground in the open	4.5
3	Dry in a box	7.7
4	In a box sprinkled with water	10.1

These results show the necessity for designing a factory of a suitable type if an edible oil of high value is to be obtained. For estate purposes it is considered that such a factory should be erected, so that high quality palm oil can always be manufactured.

Although it is scarcely possible to form an idea of the actual requirements of such a factory from descriptions of plants already working, special reference will be made to one, since it will be seen later that many of the problems associated with the industrial preparation of a high class oil have been worked out in that factory.

The factory which belonged formerly to the "Syndikat fur Oelpalmen Kultur" is at Maka in the country formerly known as German West Africa. The factory which is near both river and railway consists of three buildings. The first contains the boiler house and engine room, in which are two steam engines of 175 H.P. and 75 H.P., the smaller engine being used for working the dynamos required for lighting purposes and as a reserve. Steam is raised by burning the residues from the oil presses and the remains of the palm bunches after removal of the fruits.

The second building, which consists of three floors and is entirely constructed of concrete, contains the plant required for the preparation of the oil. The detailed list is as follows :—

6 Hydraulic presses for whole fruit and 2 for pulp

4 Depulping machines

4 Nut crackers with sieves

2 Filter presses

4 Settling tanks

1 Hot chamber for drying palm kernels.

The third building contains stores and offices.

The method of working is as follows :—The fruits are removed from the bunches by beating, sorted by sieving and conveyed by an elevator to the top floor, where they are placed in boilers furnished with superheated steam coils. After heating, the fruits are transferred to the hydraulic presses on the floor below in which they are subjected to a pressure of about 1 ton per sq. inch. The expressed oil is run into settling tanks, thence pumped to the third floor and passed through a filter press.

After removal from the hydraulic presses the fruits are treated in depulping machines and the nuts separated. The pulp is then further pressed after which it is used as fuel for the boilers. The nuts are dried in a hot chamber and then cracked, the shells and kernels being separated by flotation in brine or clay suspended in water, in which the kernels float while the shells sink. The kernels are then dried for export.

This factory can treat in one week, working 24 hours a day, 345 tons of fruit, (equivalent to 517 tons of bunches), producing 64 tons of palm oil and 24 tons of kernels. The yield of oil calculated on the whole fruit is therefore about 18.6 per cent.

Application of the General Principles of Oil Expression to Palm Oil.

Although the broad principles underlying the preparation of palm oil are the same as for other oil seeds or fruits, namely the reduction of the raw material to a fine condition, followed by heating and pressing, it will be seen that the details require some modification.

Thus there can be no preliminary crushing of the whole fruit on account of its character, and the presence of the kernel which contains a different oil. The heating too, which is generally to facilitate expression by reducing the viscosity of the oil, is also a very important feature of this process, since upon its efficiency depends to a large extent the freedom from acidity and consequently the value of the oil.

The expression must also be carried out carefully, since with such a soft fruit there is a tendency for the oil to squirt during expression (especially if open type presses are employed) thereby forcing out a certain amount of cellular material, which will ferment and cause decomposition of the oil.

Also on account of the character of the fruit it is of great importance to press as rapidly as possible after separation from the bunch, and for this purpose a continuous machine, such as the Anderson Oil Expeller, is recommended for the preliminary pressing.

With regard to the use of an Expeller, the main idea is not to reduce the pericarp of the fruit to pulp, but to submit the whole mass to a uniform pressure in order to reduce the oil content as far as possible before passing the material through the depulping machines. If the fruits were depulped without such a preliminary pressing, it would mean that the same quantity of pulp would be mixed with a larger quantity of oil, thereby increasing the chances of the latter being contaminated.

Expellers for use in palm oil factories should be much larger than those usually employed in the treatment of copra and small oil seeds, since the size of the discharge opening will have to be at least as large as a nut and the diameter of the screw about 40 inches. The mass as discharged from the expeller consists of nuts surrounded by partially crushed pulp, and is then treated in a depulping machine. These machines consist of a series of revolving knives or saws which strip the pulp from the nuts. After separation the pulp is heated before the final pressing in order to dry it and to facilitate the expression of the oil. If the wet pulp were subjected to the high pressures usually employed in oil pressing (about 2-3 tons per sq. inch) a large amount of cellular matter would be expelled with the oil. The objection to this is the fact that this cellular matter begins to ferment almost immediately, thereby increasing the acidity of the oil.

Summarised briefly the chief points to be noted in the preparation of edible palm oil are : —

(1) The selection of ripe and undamaged fruit.
(2) The preliminary heating of the fruit.
(3) Continuity of working.
(4) The drying of the pulp previous to the second pressing.

Consideration of Machinery Required.

Having considered the main principles involved in the preparation of an edible palm oil an attempt will now be made to describe in outline the machinery required ; taking as a basis for calculation an estate of 5,000 acres in full bearing with palms planted 30 ft. apart on the triangular system the following figures are obtained :

Number of palms per acre...	55
Total number of palms	275,000
Maximum number of bunches per palm per annum	12
Total maximum per annum	3,300,000
Maximum number of bunches every five days ...	45,200
Hanging distance required per bunch	1¼ ft.
Hanging distance required for five days harvest ...	19,000 yds.

The bunches would be harvested when the fruits are almost ripe and still attached to the stems. The 10,000 bunches which may be taken as a maximum for a daily harvest would be transported to the factory in Decauville trucks, fitted with cross bars on which the bunches would be hung. On arrival at the factory the bunches would be transferred to sheds also fittted with numereus cross bars, arranged in four sets one above the other. The fruits would be hung on the cross bars till ripe which would take about five days. It is estimated that two sheds each 110 yards by 28 yards, with cross bars 3½ ft. apart, would be required for the maximum five days' crop. Between the cross bars planks would be placed to enable the coolies to walk round and knock off the ripe fruits. This work is easy and can be carried out quickly if the bunches are hanging breast high and the fruits allowed to fall. When as many as possible of the fruits have been knocked off, the bunches would be transferred to a cable conveyor, working at right angles to the lines of cross bars, and taken to a shed to be split up for the removal of the remainder of the fruits. Three endless belts running along the bottom of these sheds would convey the fruits to the expression machinery; it would be necessary to have other coolies stationed beside these belts to remove rotten or damaged fruits.

Each belt would supply one set of machines comprising a boiler for heating the fruits, an expeller and a depulping machine, the respective capacities of which would have to be calculated. According to the above figures each of the belts would have to convey a maximum of 7½ tons of fruits per day assuming that each bunch yielded about 11 lbs., but in practice the weight would probably not exceed 4 tons. The endless belts convey the fruits to the heaters which also act as driers, and through which the fruits pass on a series of endless belts fitted one above the other. The temperature of the chamber would depend upon the speed of the belts which can be regulated ; the greater the speed the higher the temperature, bearing in mind that fruits can only withstand a temperature of 160°C without deterioration of the oil.

The fruits would then be transferred to the filling troughs for the expellers. Theoretically the whole of the oil in the fruits could be expressed in the expellers as it is quite possible to alter the pressure from the time when the fruits fill the chamber to the time when the nuts touch, but since the reduction in volume, consequent upon the removal of the pulp from round the fruits, is much greater than the volume of oil expelled this result is never attained.

After discharge from the expeller the pulp is crushed, but, as it will be still adhering partially to the nuts, the whole mass must be depulped in one of the many types of depulping machines on the market.

After being separated from the nuts the pulp should be reheated and dried in order to reduce the moisture content, and at the same time to coagulate the albuminous matter, thereby facilitating subsquent expression of the oil. Since the pressure to which the pulp must be subjected in order to obtain the maximum quantity of oil is about 3

tons per. sq. inch, it is important that the pulp should be as dry as possible, otherwise large quantities of albuminous matter will pass out with the oil. This would result not only in a loss of oil held up mechanically when filtering, but the presence of this mucilage tends to set up fermentation thereby increasing the acidity of the oil.

No remarks on the subject of presses are necessary as there are numbers of types working successfully. The residue from the presses is used as fuel to fire the boilers.

The nuts after drying would be broken in a nut cracking machine, of which there are now several useful types. The separation of kernels and broken shells by immersion in brine solution is primitive and it is hoped that before long some more satisfactory method will be available, possibly one designed on the principle of a winnowing machine. The drying of the nuts previous to cracking is essential otherwise the kernels will be spoiled.

The treatment of the second quality fruit, over ripe or damaged, would be carried out in the same way but in a different set of machinery.

As regards the preservation of the oil it has been shown that oil free from mucilage and water will keep well.

The transport of the oil would have to be effected in barrels or tanks, provided of course that the output is not sufficient to warrant a tanker (Tank steamer). Barrels, as in West Africa, could be made in the factory from their component parts but tanks would have to be imported.

It is not intended to discuss more general problems such as that of power but, taking as a basis the 250 H.P. required for the Maka factory, an estate of 5,000 acres producing about 0.6 tons of oil per acre per annum would require about 220 H.P. This power would have to be supplied partly by steam and partly by gas or crude-oil engines.

Having regard to present conditions it is certain that some time will elapse before a factory on these lines is erected. The scheme leaves much to the initiative of the person in charge, who should on no account permit one firm to supply the whole of the plant but should endeavour to make a selection of the best types of the various machines and then combine them.

C.D.V.G.

NOTES ON THE FERTILISING VALUE OF TAPIOCA REFUSE.

By C. D. V. Georgi.

AN enquiry has been received regarding the suitability of refuse from tapioca factories as a fertiliser.

This refuse consists of the outer skin, fibre and other debris remaining on the sieves through which the pulped roots are passed after maceration and grinding with water.

The refuse is a greyish white powder containing a proportion of short fibres.

The results of analysis expressed in parts per cent are as follows:—

Moisture	11.6
Ash	28.7
Organic and volatile matter (by difference)	59.7
Nitrogen	0.61
Potash (K_2O)	0.58
Phosphoric acid (P_2O_5) ...	0.56

From these results it will be seen that the refuse has only a small fertilising value; the total plant foods, nitrogen, potash and phosphoric acid calculated on the dry material amounting to less than 2 per cent.

Although this refuse would not pay for the cost of transport it could however be utilised as a fertiliser on the estate where it is produced, thereby conserving as far as possible the plant nutrients in the soil.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of August, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	144.50	81.6	90.54	73.38	17.16	76.0	.790	72.2	73	...	5.28	0.95
Pahang, Kuala Lipis	...	...	80.6	89.8	70.2	19.7	75.8	...	...	...	...	10.10	2.08
Johore, Johore Bahru	...	...	...	85.95	73.09	...	...	...	...	...	...	10.06	2.61
Singapore, Kandang Kerbau	...	...	81.9	84.8	76.3	...	77.3	.881	...	81	Calm	11.55	1.96
Malacca, Durian Daun	...	121.	80.	87.	73.	14.	78.	.896	...	81.	N.W.	9.85	1.61
Negri Sembilan, Seremban	...	155.	79.2	88.9	71.4	17.5	75.5	.817	73.	81.4	E.	6.64	1.20
„ Kuala Pilah	...	148.6	80.8	89.	69.7	19.3	76.9	.854	74.7	82.	...	5.85	.17
„ Port Dickson	...	149.8	81.6	87.4	74.3	13.1	77.	.886	74.5	79.	...	6.70	1.49
Selangor, Kuala Lumpur	...	145.6	81.6	89.1	72.1	17.0	76.5	.816	73.1	76.	N.E.	3.73	2.36
„ Klang	...	...	83.4	85.4	74.1	11.3	76 0	...	...	...	...	7.31	2.36
„ Kuala Selangor	...	...	...	89.5	69.6	19.9	...	...	...	...	...	2.09	.67
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Telok Anson	...	...	81.38	92.	69.	23.	76.62	.854	...	80.	...	4.76	1.22
„ Ipoh	...	...	81.22	95.	70.	25.	76.24	.840	74.36	80.	...	2.55	1.53
„ Taiping	...	...	83.18	95.	71.	24.	76.54	.825	...	73.	...	7.63	1.53
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	9.84	1.25
„ Parit Buntar	...	...	83.32	94.	71.	23.	78.	.890	...	79.	...	4.96	1.85
Penang, George Town	...	150.	81.7	93.	69.	24.	78.7		71.5	87.3	S.	10.70	3.46
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	18.49	3.85
Perlis, Kangar	...	...	...	86.96	73.13	13.83	...	...	...	...	...	11.70	2.25

THE

Malayan Agricultural Journal.

Vol. X. September, 1922. No. 9.

EDITORIAL.

THE importance has long been recognised of bringing the practical results obtained from the work of research officers in this Department to the knowledge of the planting community in general and more especially of the small holder, and at the same time the methods and requirements of the cultivator to the knowledge of the research officer. To achieve this must be bridged a gap which in its extreme width extends on the one hand from a European officer trained in the latest developments of Science to, on the other, a simple and often illiterate Asiatic peasant.

The easier problem of conveying these results to the European planting community can be met by publications in English, by correspondence, and when necessary by lectures and demonstrations. While these same methods are applicable to Asiatic small holders, they are not in themselves sufficient, more especially because ancient prejudices have often to be overcome and because the small holder requires to be educated to some extent to enable him to understand the information conveyed to him. For these two reasons personal teaching and demonstration both for adults and for children become of great importance and necessitate the services of officers well known to and trusted by the peasants among whom they work.

For the work described, a staff of two Agricultural Instructors was provided in 1914. Plans were made for increasing this staff and its activities, but these could not be put into operation owing to the financial stringency during recent years.

There is, however, also in existence a considerable staff of Inspecting officers, both Europeans and Malays, whose main duties in the past have been to ensure the adequate treatment of pests and diseases of cultivated plants. In order to overcome the difficulty caused by lack of money and to proceed with the much needed extension of Agricultural Instruction, an arrangement was approved and put into operation in July last whereby the Inspecting officers undertake a portion of the duties of Instructors.

The Instruction staff retains in its charge the organization of School Gardens and the dissemination or agricultural information obtained by research in the laboratories or in the Experiment Stations

through the medium of an Agricultural periodical published in the Malay Language under the title of "Warta Perusaha'an Tanah." It also advises and co-operates with the Inspection Staff. But much of the field work in personal contact with the peasants is now the duty of the Inspection Staff. The activities of these officers commence in the Experiment Stations, such as that recently established in Malacca for padi breeding, and in the testing plots for padi such as those recently planted in the Province and near Kuala Kangsar. On these plots pure strains of padi selected by the Botanist from the padi Experiment Station at Titi Serong are tested for their suitability under varying local conditions. The Inspectors are also responsible for establishing demonstration plots to introduce to the small holders not only approved strains of padi but also any new crops that have been proved suitable for cultivation, such as roselle and kapok. Another function is to distribute seed of improved strains of plants, such as padi, and to see that such seed is properly planted and kept reasonably pure in later generations The Inspectors give demonstrations and advice concerning the control of pests and advice on new points connected with the cultivation of established crops, particularly rubber and coconuts. Finally they give assistance in organising Agricultural Shows, although the Instructors also take a considerable share of this work.

While the Inspectors may in the course of their duties obtain information useful in connexion with schemes for co-operation, they are not expected to take a more active part in such work, as they have not the time for it.

Posters or pamphlets regarding new crops or pests of crops are prepared in Asiatic languages by either the Instruction or the Inspection division as required. These as well as the Malay Bulletin are distributed by reference to a list, kept up to date by the Department, of all Malay Chiefs, penghulus and other Malays of standing, as well as all officers of the Education and Co-operative Departments. By this method the Department keeps in close touch with those most likely to benefit by the publications.

The success of the scheme depends on close co-operation between all the branches of the Department; on the provision to the Field Officers of full information on all new points arising from Research; and lastly to no small extent on the energy and initiative of the Malay Officers who form a large proportion of the Inspection Staff and on their ability to obtain the confidence and interest of those among whom they work. It is hoped that, as the scheme matures and the small cultivators learn to realise the value of the help and advice at their disposal, a solid bridge will have been built across the wide gap separating the research officer from the Asiatic cultivator.

SOME MALAYAN VEGETABLE OILS AND FATS OF MINOR IMPORTANCE.

By C. D. V. Georgi.

THE Departmental exhibit of vegetable oils and fats at the recent Malaya-Borneo Exhibition included a number of the lesser known oils and fats, which had been prepared from seeds and fruits cultivated locally.

A list of some of these is given in the following table :—

Name of Oil or Fat.	Malay Name.	Botanical name of Plant.	Source.
Brazil nut Oil	...	*Bertholletia excelsa* ...	Government Plantations, Kuala Lumpur.
Calophyllum Oil	Minyak ... Penaga	*Calophyllum Inophyllum*	Public Gardens, Penang,
Croton Oil ...	Minyak ... Chengkian	*Croton Tiglium* ...	Government Plantations Kuala Lumpur.
Pulasan Fat ...	Minyak ... Pulasan	*Nephelium mutabile*	Datok Mat Sah, Penghulu Pasangan District, Kuala Selangor.
Rambutan Fat	Minyak ... Rambutan	*Nephelium lappaceum*	" "

Croton Oil is the only one which can be considered at present as economically important, and this oil is used only to a limited extent in pharmacy. In the case of the others the extraction of the oil can only be regarded as of minor importance and of scientific interest.

Brazil nuts, Pulasans and Rambutans are known primarily as fruits and hence the expression or extraction of the oil is very seldom carried out, while in the case of Calophyllum the tree from which the seed is obtained is only sparsely distributed in this country and the quantity of oil available very small.

As however all these trees can be grown in this country it was considered advisable to examine the samples of oils and fats and ascertain whether their analytical constants were comparable with those of the same oil or fat from other sources.

Brazil Nut Oil.

Brazil nut oil is obtained from the seeds of the Brazil nut tree *Bertholletia excelsa*, (Natural Order *MYRTACEAE*) indigenous to South America, but which can be cultivated successfully in this country.

The nuts are in great demand as a dessert nut and therefore the oil is very little known. In South America a certain amount of the oil is pressed out by the natives and used for edible purposes, but in countries to which these nuts are exported only those which are spoilt

and unfit for sale as dessert are utilised for oil expression, the oil being used for soap making purposes.

An investigation of the nuts from the Government Plantations at Kuala Lumpur gave the following results:—

The nuts were of characteristic appearance being about 1½ inches long and 1 inch wide at the base, with a shell only about $^1/_{20}$ of an inch thick.

Average weight of nut	6 grams.
Percentage of husk	51.4
Percentage of kernel	48.6

Kernel.	Per cent.
Moisture	6.5
Oil (Chloroform extract)	60.3
Residue (by difference)	33.2
Oil (calculated on dry kernel)	64.5
Oil (calculated on whole nut)	29.3

A sample of warm pressed oil was found to have the following analytical constants, which will be seen to compare favourably with those given by Lewkowitsch in "Chemical Technology and Analysis of Oils, Fats and Waxes," Vol. II, page 189.

Oil.	Present sample.	Lewkowitsch.
Density (15.5°C)	.9166	.9180
Refractive Index (20°C) ...	1.4711	...
Saponification Value	192.0	193.0
Iodine Value (Wijs method) ...	101.7	106.2
Acidity (Oleic Acid per cent.) ...	0.6	...
Fatty Acids.		
Solidifying point (Titer Value) ...	31.4°C	31.1-32.2°C
Mean Molecular weight ...	297.5	...

The cold pressed oil was practically colourless and odourless, and its flavour was similar to that of the nut. The oil was easily expressed, especially when the nuts were slightly warmed, but the oil then developed a yellowish colour.

There is no doubt that this oil is highly suitable for edible purposes, while the comparatively high solidifying point of its fatty acids indicates its utility for the manufacture of soaps. It is however most unlikely that it will ever be brought into general use for either of these purposes, since the supply of nuts is relatively so small.

CALOPHYLLUM OIL.

Calophyllum Oil is obtained from the seeds of *Calophyllum Inophyllum*, (Natural Order *GUTTIFERAE*) a large tree indigenous to the coastal districts of tropical Asia and East Africa.

The seeds when received from Penang were still green, but gradually turned brown, the surface becoming shrivelled. The seeds were round, about 1½ inches in diameter, and consisted of a thick outer shell, containing a small kernel about ¾ inch in diameter.

The shell was woody on the outside, spongy in the middle while on the inside there was a thin, brown, highly polished lining or skin.

The kernels which were loose in the shells were yellowish when freshly opened but turned brown on exposure to air. This discolouration was confined to the surface.

The average weight of the fresh green seed was found to be 13 grams (nearly ½ oz.) the kernel weighing 2.95 grams. The proportion of husk to kernel was found to be as follows:—

Husk	77.3 per cent.
Kernel	22.7 „ „

The kernels lost a considerable amount of moisture on keeping, the average weight of some kept for 8 months decreasing to 2.32 grams, representing a loss of about 20 per cent.

The results of analysis of these partially dried kernels were as follows:—

	Per cent.
Moisture	21.6
Oil and Resin (Chloroform extract) ...	48.1
Residue (by difference)	30.3
Oil and Resin (calculated on dry kernel) ...	61.4
Oil and Resin (calculated on fresh kernel) ...	37.1
Nitrogen in dry oil-free residue	3.58

A quantity of the kernels was warm pressed in a laboratory hand press in order to obtain a sample of the oil for the determination of the analytical constants.

The expressed oil was thick, dark greenish brown in colour; on standing a small amount of a greenish sediment separated out. This consisted principally of resin which was present in the oil to the extent of about 10 per cent.

The resin was extracted by shaking the crude oil with a 10 per cent. solution of sodium carbonate, the resultant oil being much less viscous and yellowish brown in colour.

The following analytical constants were obtained for the oil (*a*) containing resin (*b*) free from resin. These results will be seen to compare favourably with those given in Lewkowitsch, "Chemical Technology and Analysis of Oils, Fats and Waxes" Vol. II, Page 301.

	Containing resin		Free from resin	
	Present sample.	Lewkowitsch.	Present sample.	Lewkowitsch.
Oil.				
Density (15.5°C) ...	.9411	.9428	.9276	...
Refractive Index (20°C) ...	1.4814	...	1.4753	...
Saponification value ...	184.2	196.0	188.4	191.0
Iodine value (Wijs method)	98.1	92.8	90.0	86.0
Acidity (Oleic acid per cent.)	17.5	...	0.9	...
Unsaponifiable matter (per cent.)	0.7	...	...	...
Fatty Acids.				
Solidifying point (Titer value)	32.1°C	33.0°C	33.3°C	...
Mean Molecular weight	298.4	289.2	291.5	...

On account of the presence of the resin which is poisonous, the oil cannot be used for edible purposes but is said to be employed locally by natives as an illuminant and also for medicinal purposes, particularly for skin affections and rheumatism.

It will be noticed that the extracted meal (after removal of the oil) contains a fair proportion of nitrogen which might render it suitable for fertilising purposes.

Croton Oil.

Croton oil is obtained from the seeds of *Croton Tiglium*, (Natural Order *EUPHORBIACEAE*) a tree indigenous to Southern India and Ceylon, but which is now found cultivated throughout Southern Asia.

The seeds are contained in small capsules somewhat similar to those of the castor oil plant. The shelled seeds are brownish in colour and rather larger than the small variety of castor oil seed. The seeds contain about 55 per cent. of oil, which has an orange yellow colour, nauseating odour and a burning taste.

The sample of oil obtained by expression was found to have the following analytical constants which are in fair agreement with those given by Lewkowitsch, "Chemical Technology and Analysis of Oils Fats and Waxes," Vol. II, page 183.

	Present sample.	Lewkowitsch.
Oil.		
Density (15.5°C)	.9501	.9375—.9428
Refractive Index (20°C) ...	1.4810	...
Saponification Value ...	212.1	215.0
Iodine Value (Wijs Method) ...	115.9	101.7—102
Acidity (Oleic Acid per cent.) ...	0.9	...
Fatty Acids.		
Solidifying Point (Titer Value) ...	15.35°C	18.6—19.0°C
Mean Molecular weight ...	274.4	...

The Iodine and Titer values for the sample differ somewhat from those quoted by Lewkowitsch, but these differences are only of the

usual order which is sometimes found when comparing samples of similar oil from various sources.

On account of its strong cathartic action Croton oil finds a limited application in pharmacy, while it is also employed in the preparation of certain liniments. It could also be used for soap making.

Pulasan Fat.

Pulasan Fat is obtained from the seed of the Pulasan, well known as a fruit in this country. The Pulasan tree is known botanically as *Nephelium mutabile* (Natural Order *SAPINDACEAE*).

When dried the seeds are flattish, pointed at one end, about 1 inch long, half an inch broad and $\frac{1}{4}$—$\frac{1}{3}$ of an inch thick.

An investigation of the seed gave the following results:—

Average weight of seed	2 grams.
	per cent.
Moisture	6.4
Fat (Chloroform extract)	59.9
Residue (by difference)	33.7
Fat (calculated on dry seed)	64.0
Nitrogen in dry fat-free residue	4.48

The material available was too small to obtain by pressure sufficient fat for the determination of the analytical constants. The residue after pressing was therefore extracted with ether and the fat thus extracted added to that obtained by expression.

Pulasan fat at the ordinary atmospheric temperature (28—30°C) is a hard white fat, melting at about 40—42°C to a yellow oil. The fat has a faintly sweet smell.

The analytical constants were as follows:—

Fat.

Density 99°C (water at 15.5°C = 1) ...	.8597
Refractive Index (40°C)	1.4579
Saponification value	199.0
Iodine value (Wis method)	41.6
Acidity (Oleic acid per cent.)	3.5

Fatty Acids.

Solidifying point (Titer value)	50.9°C
Iodine value (Wijs method)	40.9

As far as can be ascertained there are no published results for this fat, but it will be seen that these constants are in close agreement with those for Rambutan fat.

This fat would be suitable for edible purposes, while the high solidifying point of the fatty acids would also render it useful in the preparation of soaps and candles. The quantity of seed available however is too small for economic purposes in these respects.

RAMBUTAN FAT.

Rambutan fat is obtained from the seed of the Rambutan, known botanically as *Nephelium lappaceum* (Natural Order *SAPINDACEAE*). This fruit like the Pulasan is well known throughout the country.

As might be expected the seeds are similar to those of the Pulasan, except that in the present sample it was noticed that they were slightly longer and more pointed than the Pulasan.

The results of an analysis were as follows :—

Average weight of seed	1.8 grams.
	per cent.
Moisture	7.5
Fat (Chloroform extract)	34.2
Residue (by difference)	58.3
Fat (calculated on dry seed)	37.0
Nitrogen in dry fat-free residue	2.55

The sample of fat for the determination of the analytical constants was prepared in a similar way to the sample of Pulasan fat to which this one is closely allied.

The fat is a hard white product at ordinary temperatures resembling Pulasan fat; it melts at about the same temperature (40—42°C) to a yellow oil and has a similar sweet smell.

The table below gives the analytical constants obtained for the present sample together with the figures given by Lewkowitsch "Chemical Technology and Analysis of Oils, Fats and Waxes," Vol. II, page 473.

	Present sample.	Lewkowitsch.
Fat.		
Density 99°C (Water 15.5°C = 1) ...	.8629	.9236*
Refractive Index (40°C) ...	1.4590	...
Saponification Value	193.4	193.8
Iodine Value (Wijs method) ...	43.8	39.4
Acidity (Oleic acid per cent.) ...	2.4	...
Fatty Acids.		
Solidifying point (Titer value) ...	51.5°C	...
Iodine value (Wijs method) ...	42.3	41.0

These results will be seen to be in close agreement with those given by Lewkowitsch.

Like Pulasan this fat would be suitable for edible purposes as well as in the manufacture of soaps and candles but is not likely to be available in sufficient quantity to be of economic importance.

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* Temperature not stated.

REGULATIONS CONTROLLING THE IMPORTATION OF PLANTS INTO THE STRAITS SETTLEMENTS, THE FEDERATED MALAY STATES AND JOHORE

By F. W. South.

INTRODUCTION.

THE regulations controlling the importation of certain plants into the Straits Settlements, the Federated Malay States and Johore are scattered in various Notifications that have appeared from time to time in issues of the different Government Gazettes. These regulations are, therefore, not very readily accessible to some of those who may have need of them and the fact that certain of the notifications have been amended by subsequent notifications renders the regulations more difficult to follow. The object of the present short article is to set forth clearly in one place the rules in force on October 31st 1922.

Throughout this article the word "plant" has the meaning assigned to it in the Ordinance and Enactments quoted below; the definition in section 2 of Ordinance 166 (Agricultural Pests) states:—

"Plant" means any tree, shrub or vegetation, whether living or dead and includes the stem, root, leaf, flower or fruit and any product or part thereof whatsoever, whether severed or attached."

The definition is quite comprehensive and clearly includes in particular seeds or fruits for planting, and such parts as stem or root cuttings, suckers, tubers or bud-wood for purposes of propagation.

At the present time the importation of plants into the Colony, the Federated Malay States and Johore through any port is subject to no control, except in the case of the few species of plants which are given in the lists below.

The Straits Settlements.

The plants of which the entry into the Colony is subject to control are; coconut and other palms, Para rubber (all species of Hevea), and sugar-cane.

Coconuts.

Three rules are still in force that were made by the Governor under "The Destructive Pests Ordinance 1908." This Ordinance was repealed by Section 27 of Ordinance 166 (Agricultural Pests), but by virtue of Section 5 (b) of Ordinance No. 131 (Interpretation) the rules themselves remain in force.

The first is Notification No. 1183 in The Straits Settlements Gazette of the 6th November, 1908. It prohibits the importation of all coconuts and other palms from Ceylon.

The second is Notification No. 509 in the Straits Settlements Gazette of the 22nd April, 1910. This prohibits the landing in the Colony of any palms, alive or dead, or any stems or roots or parts of stems or roots of palms, from Sarawak, and authorises the destruction of any such article, if landed in the Colony from Sarawak.

It does not apply to the nuts of the coconut or betel-nut palm or to the husks of coconuts or to oil expressed from coconuts.

The third is Notification No. 628 in the Straits Settlements Gazette of the 31st May, 1912. This prohibits the landing in the Colony of any palms, alive or dead, or any stems or roots or parts of stems or roots of palms or of any products of palms other than such as are expressly exempted from the operation of the Order, from the Philippine Islands. The exempted products are dried copra and the oil expressed from coconuts.

Recent Rules.

Section 22 (i) of Ordinance 166 (Agricultural Pests) states :—

"The Governor may make rules for preventing the introduction of pests into the Colony or any part thereof and for preventing the spread of pests therein. Such rules may provide, amongst other things, for

(*a*) prohibiting the landing in the Colony from places outside the Colony of any plant or animal the landing of which may appear to the Governor to be likely to introduce any pest;

(*b*) the treatment or destruction of any plant or animal which has been landed and of the packages, cases, pots or coverings in which the same may be packed.

Any such rule may be absolute or subject to such conditions and exceptions as may be expressed therein and may apply to the introduction of plants or animals either generally or from any specified place."

Section 2 of the Ordinance states ;—

" "Pests" includes every insect, invertebrate animal, rodent, plant and fungus which is destructive or injurious, or apt to be destructive or injurious, to cultivated plants."

Rubber.

Notification No. 1011 in the Straits Settlements Gazette of the 11th June. 1920 contains The Agricultural Pests Rules, 1919, Amendment Rules, 1920 made by the Governor in accordance with the powers conferred on him by Section 22 of Ordinance 166 (Agricultural Pests) as quoted above.

Rule 2, as further amended by Notification No. 1531 in the Gazette of the 30th September, 1921 and by the sense of Section 2 of Ordinance No. 166 (Agricultural Pests) Amendment Ordinance, 1922,

prohibits the landing in the Colony from any place outside the Colony of any plant of Para rubber, this expression including all species of Hevea, except with the written permission of the Secretary for Agriculture, S.S. and F.M.S. and subject to the terms and conditions, if any, imposed by him when granting the permission.

SUGAR-CANE.

The importation of sugar cane is controlled by The Agricultural Pests (Sugar-cane) Rules, 1920 made by the Governor in accordance with the powers already quoted. The rules are contained in Notification No. 1495 in the Gazette of the 27th August, 1920. Paragraph 2 when amended by the sense of Ordinance 166 (Agricultural Pests) Amendment Ordinance, 1922, is as follows:—

"No person shall land or cause to be landed in the Colony from any place outside the Colony any plant of sugar-cane, *Saccharum officinarum, L.* except under the following conditions:—

"(1) All shipments shall be confined to material for planting purposes only and shall be accompanied by a certificate signed by an officer of the Government Department of Agricuture of the exporting country, or by any competent person therein previously approved by the Secretary for Agriculture, S.S. and F.M.S, to the effect that it was taken from healthy plants and was at the time of packing, so far as could be ascertained, free from pests.

"(2) The Secretary for Agriculture, S.S. and F.M.S. shall be notified of the arrival of all shipments of cane plants, and they shall be inspected on landing before delivery by an Inspecting Officer who shall have power to destroy any diseased plant found, together with the packages, cases, pots or coverings in which the diseased plants may have been packed or to order their disinfection as he may think fit.

"(3) All imported cane plants shall be quarantined in nurseries from which no such plants shall be removed without the written permission of an Inspecting Officer."

The definition of an Inspecting Officer is given in Section 2 of Ordinance 166 (Agricultural Pests).

THE FEDERATED MALAY STATES.

In the Federated Malay States the plants of which the importation is controlled include only Para rubber (all species of Hevea) and Sugar Cane.

Section 21 (i) of the Agricultural Pests Enactment, No. 13 of 1913 confers on the Chief Secretary the same powers to make rules as are conferred on the Governor in the Colony by Section 22 of Ordinance 166 (Agricultural Pests); the wording of the two sections is practically identical if "the Federated Malay States" is substituted for "the Colony."

The terms "pest" and "plant" as defined in Section 2, sub-sections (vi) and (vii) of the Agricutural Pests Enactment, 1913 have the same meaning as in the Colonial Ordinance already quoted.

Rubber.

Notification No. 3931 in the Federated Malay States Gazette of the 26th August, 1921, as amended by the sense of Section 4 of The Agricultural Pests Enactment, 1913, Amendment Enactment, 1922, contains a rule made by the Chief Secretary prohibiting the landing in the Federated Malay States from any place outside the said States of any plant of Para Rubber (all species of Hevea) except with the written permission of the Secretary for Agriculture, S.S. and F.M.S. and subject to the terms and conditions (if any) imposed by him when granting such permission.

Sugar-Cane.

Notification No. 2943 in the Gazette of the 16th July, 1920 contains the rules regulating the importation of sugar-cane. When amended by the sense of the Agricultural Pests Enactment, 1913, Amendment Enactment, 1922, it imposes exactly the same conditions as are imposed by the Colonial Agricultural Pests (Sugar-Cane) Rules 1920 quoted above and the wording is practically identical.

Johore.

The plants of which the importation into the State of Johore is controlled are Para rubber (all species of Hevea) and sugar-cane. Section 20 of the Agricultural Pests Enactment, No. 20 of 1921 confers on his Highness the Sultan in Council the same powers to make rules as are conferred on the Governor and the Chief Secretary respectively by the Ordinance and the Enactment referred to above. Section 2 sub-sections (vi) and (vii) give definitions of "Pest" and "Plant" identical with those already quoted.

Rubber.

In Notification No. 18 in the Johore Gazette of the 15th January 1922 His highness the Sultan in Council makes the following rule in exercise of the powers conferred on him by Section 20 of the Agricultural Pests Enactment, 1920.

"No person shall, except with the written permission of the Inspector of Agriculture Johore, in that behalf, and subject to the terms and conditions (if any) thereby imposed, land or cause to be landed in the State from any place outside the said State any plant of Para rubber (all species of Hevea)."

Sugar-Cane.

The same Gazette Notification also contains the rules relating to the importation of sugar-cane, as follows:—

"No person shall land or cause to be landed in the State from any place outside the State any plant of sugar-cane, (*Saccharum officinarum*, L,) except under the following conditions:—

"(1). All shipments shall be confined to material for planting purposes only and shall be accompanied by a certificate signed by an

officer of the Government Department of Agriculture of the exporting country, or by any competent person therein previously approved by the Inspector, to the effect that it was taken from healthy plants and was at the time of packing, so far as could be ascertained, free from pests.

"(2) The Inspector shall be notified of the arrival of all shipments of cane plants and they shall be inspected on landing before delivery by an Inspecting Officer who shall have the power to destroy any diseased plants found, together with the packages, cases, pots or coverings in which the diseased plants may have been packed or to order their disinfection as he may think fit.

"(3) All imported cane plants shall be quarantined in nurseries from which no such plants shall be removed without the written permission of an Inspecting Officer."

In these rules "Inspector" means the officer appointed by His Highness the Sultan in Council to be Inspector of Agriculture for the State. While "Inspecting Officer" means any Inspector, subordinate to the Inspector of Agriculture, duly appointed under the Agricultural Pests Enactment.

Revision of Rules.

The rules as at present in force can scarcely be considered to exercise sufficient control over the importation of plants. Small parcels of plants can now enter the Colony, The Federated Malay States and Johore at any port and might introduce serious pests. Moreover cotton and perhaps a few other plants should be added to the list and coconuts should not be allowed free entry into the Federated Malay States and Johore.

The control of plant importation into countries such as these that rely on outside sources for part of their supplies of fruit and vegetables is by no means an easy matter. It is most important not to interfere unduly with trade, but it is equally important to safeguard extensive and valuable cultivations from the danger of new pests and to ensure that new agricultural crops, that may be introduced on a commercial scale in this country, do not bring with them any important pests not existing here. A careful balance has to be struck between these conflicting requirements.

The Agricultural Department is now making it a matter of routine to ask that an Inspector be allowed to examine any new plants likely to be grown on a commercial scale, that are from time to time brought into the Colony or the Federated Malay States, even when such importations are not legally controlled, in order to ensure that the imported plants are healthy.

Proposals have been made to the Governments of the Colony and the Federated Malay States that new rules be brought in consolidating in one place the existing rules; increasing control by the establishment of Entry Ports; establishing a definite method of procedure in the case of plants subject to control; and forming a schedule of plants of

which the importation is controlled, to which schedule additions can from time to time be made. If the suggested revised regulations receive the approval of the Governments they will be published and commented on in a future number of the *Malayan Agricultural Journal.*

The reasons for controlling the import of the plants given in the lists above are contained in the various Gazette Notifications referred to and these should be consulted if reasons are required. It is, however, evident that only a scientific officer well acquainted with the pests and diseases of tropical crops in various parts of the world can give advice in a technical matter of this nature.

LIGHTNING INJURY TO HEVEA BRASILIENSIS.

THE following is an abstract from a paper by Carl D. La Rue, on "Lightning Injury to *Hevea Brasiliensis*," appearing in "Phytopathology" Vol. 12. No. 8. The information contained therein is of interest, as the same type of injury and, in many cases death of young and old rubber trees have been noted in Malaya. As the author points out, it is extraordinarily easy wrongly to diagnose such cases of injury, and attribute them to fungus origin.

Injury to the rubber tree, by lightning, is seldom shown by the splitting or tearing of trunks or branches. The first symptom, drawing attention to the injured tree, is the wilting of the leaves about a foot from the tip of the stem, while those above and below this point are normal. The trunk soon becomes affected, dying back until the root is reached. Several days may elapse from the time the injury is first noted until the death of the tree.

By the time this stage is reached the bark, which was first affected, frequently shows the presence of Diplodia spores, and the case is diagnosed as "Diplodia die-back".

Frequently a number of trees may be killed in one spot, although sometimes only one. The curious fact that the tip of the stem almost always appears normal, while the bark below is dead, is attributed to the rosette of leaves at the tip in some way protecting the stem at this point. The same type of injury had become familiar to the author before he noticed it in young plantations, but, the injury was not, at first, attributed to lightning, until a wire cup hanger, on a tree showing similar injury, was found to have been melted by lightning, this clue being followed until conclusive evidence was secured to show the cause of injury to be also due to lightning. The injury had previously been attributed to Diplodia and the organism in question named *Diplodia rapax*. The author found Diplodia to be the only organism constantly present, this is now known to be secondary and not the cause of death of the tree.

The injury is most pronounced in the cambium region, the tissues of which turn a deep purple and decay rapidly making it easy to trace the progress of the injury. This purple discolouration is regarded by the author to be diagnostic for this type of injury and closely resembles the progress of an infection. The colour often extends outward into the bark nearly to the cork. The dead bark is very different from bark killed in other ways.

Undoubtedly many cases of "die back" in the tops of Hevea trees are due to lightening and wrongly attributed to Diplodia or other organisms.

F. R. M.

INSTRUCTIONS FOR FORWARDING SPECIMENS OF PLANTS ATTACHED BY A FUNGUS DISEASE.

WHEN specimens are received by the Department of Agriculture for Mycological examination, it frequently happens that they arrive in an advanced state of decay which makes diagnosis of the trouble difficult. The object of this note is to give to future senders, instructions which, if carried out, will greatly assist the Mycological staff in determining the cause of a disease.

I. Specimens of branches or roots.

The cut ends should be disinfected—either tarred over or treated with a disinfectant such as Solignum. This will help to keep out secondary organisms which enter through the exposed surfaces and set up decay in wood which, when despatched, may have been quite healthy.

When branches or roots have fungus threads growing along the surface, it does not always follow that the specimen is being attacked by the fungus. The bark underneath the threads should be scraped and the appearance of cortical tissues noted. If the tissues look healthy or otherwise the fact should be mentioned in the covering letter forwarded with the specimens. The scraped specimen should be sent as well as a similar unscraped one. If fructifications of a fungus are associated with such threads these should also be forwarded.

II. Specimens of diseased fruits.

The following specimens should be sent if possible:—

(*a*) A healthy fruit separate from the others.

(*b*) A fruit which is just beginning to show signs of disease. Any wounds on the fruits should be mentioned in the covering letter, as well as any other points which are considered to be abnormal.

(*c*) A fruit in a more advanced state of decay but not completely rotted.

If the above are sent in one parcel the three stages should be separated from each other. If possible the specimens should be wrapped in cotton wool which has been previously soaked in formalin and partly dried.

III. Specimens of diseased leaves.

Early and later stages of the disease should be sent accompanied by details of the attack and remarks as to the condition of soil and roots.

IV. Plants in general.

Plenty of material should be sent, and where it is possible the specimen should include the apparent boundary between diseased and healthy tissue.

Taking the foregoing remarks as a basis, senders should use their discretion when forwarding specimens, always remembering, that, in the case of leaves and fruits and small plants, completely decayed specimens, are, as a rule, useless for examination.

A. T.

THE ERADICATION OF SENSITIVE PLANT MIMOSA PUDICA

EXPERIMENTS WITH SODIUM ARSENITE.

EXPERIMENTS with a view to the destroying of the Sensitive Plant by poisoning with sodium arsenite were carried out at Raub in June 1921 by the Assistant Agricultural Inspector, Pahang North. This plant is found practically all over the Peninsula, chiefly on waste land, and bids fair to do considerable damage to pasture and hill-padi land. It is of very hardy growth and seeds prolifically, the seeds being well protected in a hard pod, provided with strong hairs — thus ensuring the spreading of this pest by animals.

The following table indicates the nature and result of four experiments carried out at Raub.

No. of Expt.	NATURE.	RESULT.
1	A thick clump of *Mimosa pudica* thoroughly sprayed with ¼ lb. Sodium arsenite in 4 gallons water.	Foliage and stems killed in 10 days. New shoots visible after 10 days.
2	A thick clump thoroughly sprayed with 1 lb. sodium arsenite in 4 gallons water.	Foliage and stems killed in 5 days. New shoots visible after 12 days.
3	A thick clump of Mimosa cut to ground-level by changkolling. The ground then saturated with solution of 1 lb. sodium arsenite in 4 gallons water.	New shoots visible after 10 days.
4	A clump of Mimosa weeded as in the previous experiment. The ground then sprayed with crude oil.	New shoots soon visible.

It is therefore evident that the plant cannot be eradicated by this means. Though the foliage and stems are killed, the roots and seeds appear to be unaffected. The only possible action at present seems to consist of continued changkolling, and destroying the roots by burning.

The question of taking steps to enforce the eradication of *Mimosa pudica* is difficult. The plant cannot be considered a pest on coconuts and rubber, as there is no evidence of any actual damage to these trees. It is undoubtedly a pest on grass, though it is questionable whether grasses can legitimately be called cultivated plants. It is therefore extremely doubtful whether action could be taken under the provisions of the Agricultural Pests Enactment, 1913; and special legislation is inadvisable until some more satisfactory method of eradicating the weed has been discovered.

F. W. S.

NOTE ON THE COMPOSITION OF CANTON MUD AND CHINESE FISH POND MUD.

By B. J. Eaton and C. D. V. Georgi.

THE following table gives the results of analyses of Canton mud and so called Chinese Fish Pond mud which have been carried out recently. These products come into the market in the form of slabs resembling baked mud or clay which however are quite friable, and consist of the dried mud from the Chinese fish ponds and are used to a large extent, especially by Chinese, for pot plants. The Canton mud is imported from China, while the Chinese Fish mud is obtained from the local fish ponds.

Mechanical Analysis.

		Canton mud (per cent.)		Chinese fish mud (per cent.)
Fine gravel	...	Nil	...	1.1
Coarse sand	...	1.1	...	12.7
Fine sand	...	17.2	...	22.0
Silt	...	22.3	...	8.2
Fine silt	...	23.9	...	10.1
Clay	...	11.9	...	21.4
Loss on ignition	...	12.4	...	15.2
Moisture	...	4.3	...	4.1

Chemical Analysis.

(Calculated on dry Material.)

	per cent.		per cent.
Nitrogen (Total)	0.44	...	0.36
Nitrogen (Nitric)	Nil	...	Nil
Phosphoric acid (P_2O_5)	1.16	...	0.47
Potash (K_2O)	0.76	...	0.34

As might be expected the mechanical analysis shows that both of the products are composed principally of the very fine soil fractions.

From a chemical point of view it will be observed that, while the Canton mud contains about double the total plant nutrients in the Chinese fish mud, neither can be termed a fertiliser.

Conclusions :—It has been found that these baked or dried muds are very suitable for the cultivation of various pot plants, particularly dahlias, chrysanthemums and asters and they are largely employed at present in public gardens and also by Europeans who specialise in the cultivation of the flowering plants mentioned above.

As soils, they may be considered comparatively rich and this combined with their mechanical texture and the open nature of the

soil when the material is broken up into small pieces for potting purposes is probably the chief reason of their successful application in horticultural work. It is also possible that the baking or drying of the muds may have affected the bacterial contents and that they resemble partially sterilised soil, which Russell and others subsequently have shown to possess valuable qualities particularly for intensive cultivation.

Comparative value.—The imported Canton mud costs locally $10.50 per bag of 180 katies (1 kati = 1⅓ lbs.) while the local Chinese fish pond mud can be procured at $1.10 per picul (1 picul = 133⅓ lbs) The latter product, although not as rich as the Canton mud, is a good substitute and much more economical. (D A. 1172/1921).

REVIEW.

INVESTIGATIONS ON OILPALMS.

By Dr. A. A. L. Rutgers.

Edited by the A.V.R.O.S. Medan, Sumatra.

THE progress made in Sumatra with the cultivation of the African Oil Palm (*Elaeis guineensis.* Jacq.) has already been referred to in the Agricultural Bulletin, F.M.S (1). The publication under review indicates the relative importance of this crop in Sumatra at the present time and contains a valuable survey of the investigations carried out by Dr. Rutgers and his assistants at the Experimental Station of the A.V.R.O.S.

The present planted area on the east coast of Sumatra is over 28,000 acres and rapid extension is anticipated. The greatest difficulties experienced have been in the preparation and marketing of the product due to bad communication with Europe during the war. These difficulties are, however, rapidly disappearing and the export of palm oil from the East should be on a sound commercial basis in the near future.

It is not possible here to refer in detail to the very important experimental results obtained and practical suggestions put forward by the Experimental Station of the A.V.R O.S. The book should be in the hands of all persons interested in oil palm culture in this country. The practical planter will find much of interest in the chapters on Planting, Upkeep of the Plantation, Preparation of the Palm oil and, finally, the Packing, Shipping and Marketing of the Crop. The preliminary paper on the varieties of oil palms and progress being made with selection of desirable types is of considerable importance to the scientific investigator. Dr. Heusser describes in detail the artificial pollination of the palm for the increased production of fruit and shows by actual experiment its necessity in Sumatra. From experience gained in this country, the reviewer is of the opinion that excessive pollination may result in the production of bunches of fruit with thin pericarp and in gradual weakening of the palms. This, however, may be due to a variety of causes, one of which being poorness of soil.

The book marks a distinct advance in oil palm culture in the East and it is to be hoped that Malaya will not fail to take advantage of the possibilities of this crop, which has already shown itself so suited to the conditions of the Peninsula.

J.N.M.

(1 Agric. Bulletin, F.M.S. Vol. IX No. 2 p 80. "The African Oil Palm in Sumatra."

SHORT SUGAR SUPPLIES AND STAGNANT TRADE.

(Reprinted from "Tropical life" of 29th June 1922).

I fear that the confectionery trade as a body, and its retail members in particular, are unlikely to have seen, and still less likely to have studied carefully, the excellent article on trade recovery which Lieutenant-Colonel Amery, M.P., contributed to the "Observer," of June 25th. Yet how very pertinent are his remarks, and with what authority does he speak.

Lieutenant-Colonel Amery (who, it will be remembered, was Under-Secretary for the Colonies, under Lord Milner and Mr. Churchill until fairly recently, when he became Parleamentary Secretary to the Admiralty) starts by dealing with the need of widening the channels for earning our living, and whilst doing so, of extending the bases for levying taxation, so that there may be an adequate amount to meet our requirements without too great a strain either on the individual or the trade or industry, as is undoubtedly the case at present with sugar. Were we to encourage sugar-production within the Empire, as America has done in her small West Indian island of Porto Rico, what a difference it would make to the future stability of our confectionery, chocolate-making and other industries at present dependent on exotic sugar supplies for their raw material.

With the advent of steadily increasing supplies of refined, i.e., of granulated sugar, direct from the estates, many profits can be saved, whilst the risks of being cornered by refiners, by the market, or by speculators would disappear. On the other hand, since Porto Rico has shown such a marvellous increase in her sugar output (see Mr. Ormesby-Gore's paper, read before the Royal Colonial Institute), an increase which seems to leave the fairy tale of the Gold Coast and her cocoa output quite in the shade, there is no reason, so far as the natural resources are concerned, why this Empire and India should not feed the world with sugar, instead of being fed by the world, and paying such a high price in the United Kingdom for what we get. Increase the preference on British-grown sugar, and, when we are self-supporting, every five pounds given means that amount knocked off the cost of your raw material.

It has always been a wonder to me, considering the importance of our sugar-consuming industries—confectionery, biscuit-making, mineral waters, chocolate, jam and preserves, etc., all needing refined sugar—that the big firms interested in such goods,now that white granulated can be produced more economically probably in the long run than any other kind, have never run estates of their own, or invested sufficient capital in established concerns to be entitled to call for the tune (at least in some degree), i. e., to specify to what degree the "breaks" shall be refined, providing, of course, their orders are sufficiently large, either collectively or individually, to take such parcels. How much better for many estates if this could be done instead of allowing, or forcing

them (as at present) to drift into the hands of banks or financiers, who do not understand their management and have no professonal interest or pride in their crops except as a means of liquidating such advances as they may have made.

"The one overmastering problem which confronts us as a nation," writes Colonel Amery, "is how to bear, witout industrial and social collapse, the burdens which the war has left behind it. . . . The real solution lies, not in trying to get rid of our responsibilities, but in strengthening and broadening the shoulders which have to bear them. . . . we have to build up an industry and a trade which can, without difficulty, carry the post-war burdens. Such statements, it appears to me, apply to the sugar-using trade to an unusual degree. Lancashire is striving against long odds to assure itself supplies of raw cotton from within the Empire, but what are the sugar consumers doing to safeguard the life and prosperity of their industries? The war and Lenin have crippled Europe, and it will remain maimed for a good generation to come. Why therefore, look to or again trust so broken a reed for your sugar supplies, as so many are doing when trying to kill all duties, etc., levied to encourage sugar production elswhere, and especially within the Empire. The great opponents to so praise-worthy a scheme are the refiners, who feel that their present easy-going method of getting rich without much effort is being cut away from under their feet. Why do they not follow the lead of rubber manufacturers and also join in the efforts that the true believers in the future of the Empire are striving after, viz., to assure supplies of sugar from our own lands, and thus be free from past troubles when trying to place our manufactured articles on the markets of the world at a fair price in competition with other countries.

Colonel Amery truly claimed that the British Empire is really the greatest undeveloped estate in the world. This means that we have the chance, above the average, of offering remunerative employment to all our people, as I long ago claimed in my book on "How to Pay for the War." Since this is so think of how easily we should be able, whilst developing this estate to increase the channels and volume of employment for all willing and anxious to make good, instead of having so many, many thousands hopelessly unemployed, in sharp contrast to the hundreds in work, including those who are overpaid for the work they condescend to do.

Such remarks are opportune, because America, rolling in wealth and anxious to kill time, as having no Empire to rule her big men naturally find life a bit monotonous, is quite willing to boom Cuba as being in the depth of despair over her sugar, in order to discourage and kill competive production elsewhere Having done this, she can then, after playing a waiting game to " buck up" production there and elsewhere under the Stars and Stripes and "boost" American sugar for all she is worth (and America is worth much when it comes to "boosting" and big talk), to monopolise the world-trade both in the production and refining of sugar, so that she can dictate terms (as we could if we developed our sugar production industries), and say what other countries can have and what they must pay for it.

There are those who smiled at my warning note in your issue of June 8th, p. 794, against postponing purchases of sugar whilst America was filling up her storehouses as fast as could be, and Germany was growing more and more menacing as a buyer as well. I would, however, claim that the situation to-day is even more strained than when I wrote, only now I believe efforts are being made for this country to secure supplies—at a price.

Furthermore I believe the competition among buyers will continue. America has the money to compete against all comers in the market for raws, and having cut them out to sell them refined sugar at her own price later on. She knows only too well, as we are now told, that the Continent already shows signs of wanting two million tons during the next twelve months, not only because climatic conditions have gone against her beet output, but because, and especially on account of, economic reasons as well. So long as the price of cereals and foodstuffs generally within the sugar-beet belt of Europe continues to be so high the cultivation of the beets will be discouraged and tend to fall to a minimum (as per their land tenure), and thus, by reducing the output of sugar, cause Europe to continue as a buyer from elsewhere, with the likelihood of increasing her demands as time goes on.

If this is how the story runs, would it not be better to develop our latent sugar production resources, and thus assure supplies for our own industries at a reasonable price?

During the three years and five months from January, 1919, to May, 1922, the U.K. has received and taken into home consumption the following tonnage of raw and refined sugars:—

Received in 41 mths.		Taken into Home Use in 41 mths.	
Raw.	Refined.	Raw.	Refined.
Tons.	Tons.	Tons	Tons.
3,823,3[illegible]4	1,250,052	3,473,486	1,176,154

This works out, over the long period shown, at 3 lbs raw to 1 lb. refined. Allowing that one-third of the raw does not go through the refiner's hands this shows as I have claimed, that this country now is receiving a ton of refined sugar to every 2 tons refined in the U.K. With America's tendency to dominate the world's sugar market and become refiner-in-chief, would it not be as well to encourage our own lands yet to be planted and estates already established, to turn out more sugar, and granulated at that, in order to prevent sugar consumers here from becoming as dependent upon America for supplies as we are at present and have been for so long, for cotton ? Ever since last November I have been warning buyers not to trust the tales of overstocks of sugar, but to buy whilst sugars were low, say at 12s. (sellers), or 10s. (buyers), on December 31st, for 96 per cent. cane against 17s. 3d. and 16s. now—just 50 per cent. more. If I have proved right in this, why not trust me to be correct also regarding the tendency for this country and Empire to become more dependent on America's good will for our refined sugar supplies ?

DERRIS AS AN INSECTICIDE.

(*Extract from an Article by N. E. McIndoo, A. F. Sievers, and W. S. Abbott in Journal of Agricultural Research, Vol XVII, No. 5.*)

Derris applied as a Powder against various Insects.

Dog Fleas.—Eight dogs badly infected with fleas (*Ctenocephalus canis* curt) were dusted thoroughly. The material was applied with a shaker and well rubbed into the hair with the hands. At the end of 48 hours no living fleas were observed. Several dead ones were seen still clinging to the hairs.

Chicken Lice.—Twelve hens badly infested with several species of lice (Mallophaga) were thoroughly treated with the powder, which was well rubbed in through the feathers. When the hens were examined two or three days later, they were free from lice.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of September, 1922.

District	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Maximum.	Minimum	Range.	Hygrometer. Mean Wet Bulb.	Vapour Tension	Dew Point.	Humidity.	Prevailing Direction of Winds.	Total Rainfall	Greatest Rainfall during 24 hours
Kelantan, Kota Bahru	...	145.38	81.3	90.4	73.9	15.5	76.1	.801	72.6	75.		10.68	3.78
Pahang, Kuala Lipis	...	...	80.7	90.2	70.0	20.2	76.0					11.84	2.75
Johore, Johore Bahru	...	..	..	87.71	73.20		...					9.48	2.12
Singapore, Kandang Kerbau	..	...	..	...	..		...					..	..
Malacca, Durian Daun	..	129.	83.	88.	74.	14.	78.	.906		82.	N.W	6.77	2.71
Negri Sembilan, Seremban	...	153.6	80.3	91.1	70.7	20.4	75.8	.811	73.1	79.2	N.E.	2.81	1.18
,, Kuala Pilah	...	152.	81.4	89.7	70.3	19.4	77.6	.868	74.9	81.4	.	7.88	4.74
,, Port Dickson	...	153.1	83.2	88.6	74.6	14.	78.5	.879	75.5	77.6	.	5.47	1.92
Selangor, Kuala Lumpur	...	146.	82.2	89.8	72.6	17.2	76.5	.806	72.8	73.	S.W.	3.81	1.06
,, Klang	...	...	81.2	86.2	74.4	11.8	76.6				..	4.02	1.93
,, Kuala Selangor	...	..	.	89.7	69.9	19.7	...				...	6.07	2.33
,, Rawang	...	...		..	..	.	...				..	...	...
Perak, Telok Anson	...	.	82.16	93.	70.	23.	77.02	.862		79.	..	3.30	2.32
,, Ipoh	...	...	81.63	95.	71.	24.	76.47	.842	74.63	78	...	7.83	1.83
,, Taiping	...	...	80.23	93.	72.	21.	76.64	.863	...	82.	...	7.12	1.77
,, The Cottage	.	...	...	..	...	...	...	...	...	..	...	13.85	2.87
,, Parit Buntar	...	...	82.45	93.	71.	22.	77.66	.884	...	81.	...	9.09	2.83
Penang, George Town	...	156.	88.8	91.	70.	21.	78.4	.942	72.	89.3	S.W.	19.6	2.67
Kedah, Alor Star	...	...										16.19	4.27
Perlis, Kangar	...	..										...	...

THE

Malayan Agricultural Journal,

Vol. X. Oct., Nov., & Dec., 1922. Nos. 10, 11 & 12.

EDITORIAL NOTES.

STAFF:

Mr. B. A. R. Gater, B.A., Cam. Dip. Agr. reported his arrival on 18th December, 1922 and assumed duties as Assistant Entomologist.

"WHOLE" RUBBER:

Interest is being shown in a new method of preparation of rubber which consists essentially of the desiccation of latex by means of a special machine similar to that used in the preparation of milk powders.

When milk is desiccated it is possible, however, to convert the dry powder again into a fluid by the addition of water, although some of the constituents *e.g.* the proteins or nitrogenous substances, are probably changed to a certain extent. When latex is converted to a dry product by suitable means, it becomes coagulated and it is not possible to convert the dry product again into fluid latex.

This process of preparing rubber by the evaporation or desiccation of latex has been patented comparatively recently in many countries including Malaya and rubber of this type has been prepared by a large company in Sumatra and the raw product stated to be of excellent quality and superior to normal sheet and crepe rubber.

If the apparatus used in the preparation of this type of rubber is similar to that used in the preparation of dry milk powders the validity of the patent may be questioned, since this type of rubber has been prepared before on an experimental scale by the evaporation of latex in thin films in hot air chamber and also by sun-drying as in the Schadt process.

An article by the Agricultural Chemist on this rubber is contained in this number of the Malayan Agricultural Journal.

ROZELLE FIBRE:

Messrs. Durege and Thomas, Ltd., 8, Beach Street, Penang, inform us that they have recently erected a fibre baling press and are prepared to receive parcels of Rozelle Fibre for grading and baling.

The bale of 280 lbs. (8 to a ton weight) is pressed to 36" × 20" × 20", but the actual shipping measurement is somewhat in excess of this, because the bales expand after pressure has been released. Their charge is $3.00 per bale for grading and baling, receiving and shipping charges extra.

LOCAL FRUIT GROWING:

Private enterprise is doing more in the way of improving our local fruit supply than may be generally known. A Chinese in Singapore whose name can be supplied to enquirers, is producing oranges of exceptionally fine flavour and size; and he is also growing figs, though it is too early to say yet with what success. The oranges are very large and juicy and have an excellent flavour, a thin skin and few pips. The name of this grower who has not only fruit but also marcotted plants for sale, can be given to enquirers who are interested; enquirers should quote as a reference this number of the Malayan Agricultural Journal and D.A. 1636/22.

The Department of Agriculture also has the name of another grower of exceptionally good fruit who also supplies marcots (D.A. 1975/22).

There are also other gentlemen who are importing good varieties of fruit trees from Java and from India.

MALAYAN AGRICULTURAL JOURNAL:

This present issue of the Malayan Agricultural Journal includes Nos. 10, 11, and 12 for October, November and December, 1922, thus completing Volume X. These numbers have been combined in this manner in order to save the extra time required to produce and bind each separately. Subscriptions for Vol. XI. January-December, 1923 are now due and should be sent in as early as possible together with the printed order form enclosed. The subscription for the year is $5/- payable in advance—this includes Nos. 1–12 and the Index, together with Meteorological Returns for the whole year which will in future be issued as a Supplement at the close of the year.

COTTON EXPERIMENTS IN MALAYA.

By H. W. Jack and W. N. Sands.

COTTON of long-staple grades is not likely to be over produced in the sub-tropical and tropical countries of the world. Moreover, strenuous efforts, with large financial backing, are now being made by the recently formed Empire Cotton Growing Corporation to extend the culture of cotton in British Colonies and Protectorates in order that the cotton spinners of Great Britain may obtain adequate supplies of the raw material for their mills. Production of long-staple cotton is in danger or being restricted below normal requirements on account of the ravages of insect pests, and further the quantity available for British factories is steadily diminishing owing to the increased consumption of this class of cotton by American manufacturers.

That every effort should be made to grow long-staple cotton is emphasized by the fact that high-grade cotton is required by the rubber and motor industries. Next to rubber, long-staple cotton is the most important raw-material used by these and the outlook for the future is unsatisfactory because there is not enough of the best grades produced to meet the demand.

Attempts to grow cotton in Malaya have been made from time to time, but hitherto, the results obtained cannot be considered satisfactory from a commercial standpoint because the yield per unit area was either too low, or the quality produced was too poor.

About 1914, trials were made with Egyptian, American Upland and Caravonica cottons at the Kuala Lumpur and Batu Tiga Plantations, but the crop records of these experiments are not available. A comparatively good return, however, was reported. In 1921 a plot of Sea Island cotton was grown at the Kuala Kangsar Government Plantation. Owing chiefly to late planting, the yield obtained from it was small, but the Superintendent considers that the prospects of cotton-growing in the district are favourable.

At the Serdang Government Plantation, Egyptian and Sea Island varieties were planted last season. Here, also, the results were unsatisfactory, apparently on account of unsuitable soil conditions.

Both at Kuala Kangsar and Serdang the experience gained of the requirements of the crop is likely to prove valuable in connection with further experiments.

In other parts of the Peninsula the 'kidney' or 'chain' cotton, (*Gossypium brasiliense*), Caravonica, Egyptian, Assam Indigenous, Garo Hill, Dwarf Patani, and other varieties have been grown on a small scale by planters. With the exception of selected strains of Egyptian and Caravonica cotton all of these have coarse short staples, and are therefore of low value.

Although the prospects of cultivating the more valuable long-staple cotton in Malaya cannot as yet be estimated, still recent trials indicate that a fair measure of success may be anticipated in average seasons. It is true that new problems connected with the crop may have to be solved, but to date the difficulties which have been encountered are for the most part those which were anticipated and can be largely avoided by close attention to the requirements of the plant and the careful control of pests.

The writers are of opinion that it would be wiser to confine initial experiments to Egyptian and Sea Island types. These cottons produce the finest, longest and strongest staples; they command the highest market-prices and further, they are derived from the same species, *Gossypium barbadense*.

As the market for the finest Sea Island cotton is very limited, types producing moderately fine grades of this class of cotton should be grown; these together with selected Egyptian varieties are required in large quantities in Great Britain. The plants can be grown as annuals, that is, they would only occupy the land for about seven or eight months of each year; this is a great advantage because pests can be better controlled, as will be described later. Again the danger of natural hybridization and mixing of seed of long and short staple varieties would be avoided. Cotton from mixed, or hybridized seed is hardly saleable.

Should experiments with Egyptian and Sea Island cottons not prove satisfactory, then some of the best long-staple American Upland or other varieties might be tried, but it is doubtful whether the market value in Europe of the lint from these would be sufficiently high to make the crop remunerative, unless the yield per acre was heavy and the cost of production low.

Small experiments have been made by the Botanical Division of the Department during the past two seasons, chiefly with the object of obtaining a supply of pure seed of selected Egyptian and Sea Island varieties for larger trials. It may be useful to record the results of preliminary observations on these in view of the numerous enquiries that have been made in regard to cotton-growing locally, because they have indicated some of the difficulties that may be expected and the manner in which they may be met.

The following selected strains of cotton were grown:—

EGYPTIAN.

1.	Assili F/21	A selected strain of the well-known brown cotton extensively grown in Egypt.
2.	Sakel E/21	A selected strain of the excellent 'Sakel' cotton which is the most profitable of the varieties grown in Lower Egypt. It is produced in large quantities, and finds a ready market at high prices.

3. 810/A/21 — A selected strain of a variety originally bred by Dr. Laurence Balls when he was in Egypt and now being largely cultivated. According to recent reports this variety is said to threaten seriously the position of 'Sakel' should it maintain its present promise, for in certain respects it is superior to that variety.

SEA ISLAND.

4. H/23 — One of the best and most prolific of the West Indian strains. Originally selected in the island of Montserrat.

5. A.N. — A good type of ordinary West Indian Sea Island cotton selected in St. Vincent.

6. U.S.S./1 — This is a prolific type selected in St. Vincent from a strain obtained from the United States.

7. V. 18. — One of the superfine Sea Island strains raised in St. Vincent.

8. V. 135. — A selected strain of one of the superfine St. Vincent cottons.

The Egyptian varieties were obtained from the Department of Agriculture at Cairo and the Sea Island from St. Vincent, British West Indies.

TIME OF PLANTING AND RAINFALL.

Cotton-growing when dependent on rainfall is usually a rather speculative undertaking. The plant succeeds best in places where the rainfall is good, but well distributed, during the first four months of its growth and then gradually decreases in the following three months when the bolls are maturing.

Judging from rainfall records it was thought that along the west coast of the Federated Malay States the optimum planting date would lie between the last week in February and the second week in March, and this has proved to be the case in the 1921 and 1922 seasons. Short dry spells occurred in March which delayed planting, retarded the germination of the seed, or inhibited the growth of the plant, but otherwise no difficulty was experienced. Cotton, once it is established, can withstand fairly dry conditions if they are not too prolonged. At the other end of the season the weather was all that could be desired and the bolls matured satisfactorily. It is a mistake to suppose that absolutely dry weather is essential at harvest. Good crops can be obtained, even if the weather is showery, provided the rains are not continuous and spells of sunshine intervene.

SOIL.

As a rule light soils of good fertility are better than heavy ones. Provided the rainfall is not excessive, some of the heavier lands may

also prove quite suitable. On poor soils the growth is stunted and the yield low. On the other hand, very rich soils often induce rank vegetative growth which leads to poor crops. Good drainage of the land is essential.

The soils on which the experiments were made were light and recently cleared of "blukar." Some difficulty was encountered in establishing the plots for although the seed germinated well many of the seedlings died. This was thought to be due to the raw nature of the land and to deleterious products resulting from the decay of the large supplies of vegetable matter that were buried beneath the soil. No pests or diseases appeared to be responsible for the death of the seedlings. The land selected for the crop should therefore be worked up some time before planting is started, or preferably the cotton should be grown on land previously cultivated. When a considerable quantity of green dressing is present this material should be allowed to dry thoroughly before it is buried under the soil. There would be no danger in using well-rotted pen-manure on poor soils.

Preparation of Land.

The methods of preparing land for cotton vary a great deal. In Malaya with the ample rainfall, and the unlikely occurrence of long periods of drought, provided the season for planting is well chosen, the ridge system appears to be the one which should be adopted. For this method the land should first of all be clean-weeded and the weeds allowed to dry after being ranged in lines 4 or 5 feet apart. Ridges should then be thrown up either by plough or "changkol," covering the weeds completely. The ridges may be high or low, but preferably not less than 1 foot high at the centre. On good soils the ridges may be 4 or 5 feet apart: four feet is usually sufficient and on poor soils three feet. In dry districts the cotton may be planted on the flat. An advantage of the ridge method is that less cotton on the lower branches is damaged by rain and the root-system of the plants is better aerated. A water-soaked condition of the soil often leads to loss of crop because it checks the elaboration of food owing to root-asphyxiation, with the result that immature bolls are shed. Any factors however, which tend to limit elaboration of food, such as periods of rain, low rate of evaporation, or little direct solar radiation, are according to Mason (1), precursors of augmented rates of shedding.

The ridge system answered well in the experiments, and damage due to rain and soil-water was almost negligible. The ridges, however, were about 15 inches high and 5 feet apart. This spacing was too wide, a width of 4 feet would have given better results because the plants did not cover the ground well between the five-foot ridges. With ridges spaced at 4 feet, there would have been a larger number of plants per acre which would have given a larger yield and the weeding costs would have been reduced.

In one plot a large shade tree was allowed to remain and this seriously affected the growth of the plants over a considerable area surrounding it. Cotton cannot be grown successfully under shade, or near to large trees.

Planting.

The usual distance of planting the seed on ridges is two feet where the soil is of average fertility, but closer spacing may be given

(1) Annals of Botany. Vol. XXXVI, No. CXLIV, 1922.

on poor land. Three or four seeds are placed in small depressions about 1 inch deep, made with a stick and lightly covered with loose soil. After a period of seven days has elapsed, provided the weather is favourable, the young seedlings will be seen. Should vacancies occur, the holes where no seedlings are seen should be resown. The supplying of "dead holes" as early as possible is desirable. The seedlings should be thinned out when about six inches high leaving the two strongest in each hole. The young plants must be kept scrupulously clean-weeded. Shallow cultivation should be practised to avoid injuring the roots. Weeding may be continued until bolls are formed, or the plants have covered the ground, but it should not be unduly prolonged as it may damage the plants.

This practice was followed in the local trials. The spacing distance of 2 feet proved sufficient on the better portions of the land, but was too wide on the poorer sandy areas; in other respects the methods were found to be satisfactory.

Flowering and Bolling.

The plants grow to a height of 4 feet or more in suitable soil. The first flowers appear in two months from the time of planting and about seven weeks later, if all goes well, the bolls which develop from them open. Flowers appear in rapid succession after the plants have reached the age of two months. About the 14th week the largest number of flowers is produced, with the result that the maximum number of bolls matures about the 21st week. This number gradually decreases up to the seventh month. Should a second crop be obtained from the basal lateral branches which develop later than the primary branches the picking season may be prolonged by one to two months.

The cotton produced on the first-formed branches is, as a rule, better in quality than that from the basal laterals.

In our experiments the growth and bolling of the Egyptian and Sea Island plants in areas with suitable soil was quite up to the average of rain-grown cotton of these varieties in other countries and a yield of 200-250 lbs. of lint per acre was indicated.

Pests and Diseases.

The factors limiting the yield of cotton in the coastal districts of Malaya appear to be insect-pests, and not climate or fungus diseases, provided the time of planting is suitably chosen and soil conditions are satisfactory.

The following important pests, identified by the Government Entomologist, were recorded as causing damage to the stem, leaves or bolls :—

Cotton-stainer	...	*Dysdercus cin*
Leaf-roller	...	*Sylepta dero*
Hairy caterpillar	...	*Euproctis sc*
Swarming caterpillar	...	*Spodoptera*
Boll-worm	...	*Earias in*

The cotton-stainer proved a serious pest and was difficult to control owing to the presence of other food-plants in the vicinity of the plots. This insect feeds on the seeds of Kapok (*Ceiba pentandra syn. Eriodendron anfractuosum*), Roselle (*Hibiscus Sabdariffa* and *H. Sabdariffa var : altissima*), Hibiscus (*Hibiscus rosa-simensis*), Hemp (*Hibiscus cannabinus*), Okra (*Hibiscus esculentus*) and other malvaceous plants as well as cotton. The chief damage is done as a result of the punctures the insect makes in young and unopened bolls in its efforts to reach the enclosed seeds. The punctures allow deleterious bacteria and fungi to enter the soft tissues and destroy or stain the enclosed lint. The mechanical effect of the perforations is negligible, and if no disease germs or spores were present, the bolls would show white cotton only on opening. The extent and nature of the damage cannot be estimated, therefore, until the bolls are ripe. The obvious and only successful remedy is to adopt preventive measures against the pest by destroying all its known food-plants in the neighbourhood, and by the enforcement of a close season during which no cotton or other food plant is allowed to exist. Continuous trapping and collection of the insect is also advisable.

It is difficult to obtain good crops of white cotton if any of the food-plants mentioned above are allowed to grow near the cotton fields, because these plants enable the insects to breed and to tide over, in large numbers, the period when no cotton is growing. As cotton is the favourite food-plant of this pest, the latter is immediately attracted to it as soon as boll formation begins. Owing to the fact that the cultivation of 'Roselle' and 'Kapok' is being encouraged locally some difficulty may be experienced in controlling the pest. As 'Roselle' is grown for its fibre alone and is reaped before it reaches the flowering stage, no trouble need be anticipated in this direction, but if the plants were allowed to fruit then they would act as a serious menace to any cotton grown within three or four miles of them, unless of course the cotton-stainer was systematically destroyed when found on the Roselle and not allowed to breed.

In regard to 'Kapok' it was found almost impossible to get the people in the West Indies to harvest the pods thoroughly, hence it was necessary to enforce the complete destruction of all the trees in the cotton-growing islands. Owing to the relatively few 'kapok' trees grown locally at the present time, and their small size, it should not be difficult to make the owners of them harvest all the pods just before they opened, in any locality where cotton was being cultivated. If this was done there would be little danger of the pest spreading from the trees to the cotton.

The details of the various methods which can be successfully employed to keep the cotton-stainer under control cannot be given here, but they may be classed under the following heads :—

1. A close season of three or four months.
2. Trapping by means of cotton seed in the close season.

3. Hand-collecting.

4. Destruction of all known food-plants in the vicinity of the cotton fields.

5. Spraying with "tuba" mixture and other sprays.

The hairy caterpillar (*Euproctis scintillans*) damages the growing shoots and leaves by feeding on them, and boring into the stems, thus causing a severe setback. Where damaged shoots are seen they should be cut out and the insect killed. Quite a number of shoots may be injured by this pest in the early part of the season.

The leaf-roller (*Sylepta derogata*) is a pest which often causes extensive damage and nearly all the leaves on the plants may be damaged or destroyed and development completely arrested. Dusting or spraying with Paris Green or Lead Arsenate are effective remedies. All attacks must be dealt with as soon as observed.

The boll-worm (*Earias insulana*) is a rather serious pest as it feeds on the seed-cotton inside the boll and is difficult to control. So far, the attacks have not assumed large proportions, but the pest is capable of causing extensive damage. As an aid to the control of this insect a close season, during which all the old cotton plants are destroyed by burning or burying, is beneficial.

As mentioned above, these are the chief pests observed so far but there are others of less importance which were noted and should be treated. Cotton is a crop that requires careful watching throughout the entire period of its growth, and the success of its cultivation will largely depend on the early recognition of attacks of pests, and the energetic application of approved methods for their control.

PICKING.

The cotton must be picked when the bolls are fully open and at fairly frequent intervals, especially in showery weather as prolonged exposure to moisture causes the seed to germinate and thereby renders it useless for planting purposes. Again if the seed-cotton is left too long it may drop from the boll to the ground and be soiled. It was found desirable to pick the cotton at least once in every three days in the local trials.

CLEANING, GINNING AND BALING.

The methods of preparing long-staple cotton for the market need not be described here, but should any further information be desired by interested persons, on these or other points, the Secretary for Agriculture will be pleased to supply it.

Characters of Egyptian and Sea Island Cottons.

The results of the examination of the cottons in the laboratory are as under :—

No.	Class.	Max. lint length. (mean of 20 seeds) in m.m.	Wt. of seed (mean of 100) in grams.	Lint index in grams.	Ginning percentage of lint.
1	Egyptian Assili F/21	30 (= 1 1/5")	.1315	6.50	33.07
2	" Sakel E/21	40	.1300	5.35	29.23
3	" 380/A/21	37	.1255	5.27	29.46
4	Sea Island H/23	48	.1425	5.90	29.28
5	" A.N.	46	.1300	4.80	26.96
6	" U.S.S./1	39	.1245	5.70	31.40
7	" V/18	48	.1270	3.95	23.72
8	" V/135	50 (= 2")	.1130	3.75	24.91

Remarks on Cottons Tested.

No. 1.—A strain of the well-known Egyptian 'Assili.' Lint brown in colour, short, even, strong and fairly fine. The lint index and ginning percentage are both high. The bolls are small, but open widely, rendering picking easy and rapid.

No. 2.—A strain of the excellent Egyptian 'Sakel' cotton which closely approaches Sea Island in several of its characters and the uses to which it is put. The lint is white with a brownish tinge, fine, strong and even. Lint index and ginning percentage are satisfactory. The bolls somewhat resemble those of No. 1.

No. 3.—This is a strain of Bolls' No. 310. The lint is white with a brownish tinge, fine, fairly long and strong but appears to be inferior in length to No. 2 ('Sakel') as grown here.

No. 4.—The best all-round and most productive West Indian Sea Island strain. The growth and bearing characters are excellent. The bolls are large; the lint white, long, strong and fine. The lint index and ginning percentage are both high for this class of cotton.

No. 5.—A good ordinary strain of Sea Island cotton, lint fairly long, fine and strong.

No. 6.—This is a prolific type of Sea Island cotton. The lint is rather short and uneven, and the strain appears to be slightly impure. The lint index and ginning percentage are good.

No. 7.—A superfine type of Sea Island. The lint although fine, long and strong, is uneven. The lint index and ginning percentage are low as is usual in this class of cotton.

No. 8.—This is another superfine type which is superior in most respects to No. 7.

The lint index is the lint contained on 100 seeds expressed in grammes. This is found to be, a more reliable indication of the productive value of a cotton than the lint percentage, provided that the different strains of any one variety under test are capable of bearing the same number of bolls.

From observations in the field and laboratory the Egyptian and Sea Island types which are likely to prove particularly useful in further experiments are Nos. 1, 2, 3, 4 and 6. It is hoped that by selection and hybridization good types suited to local conditions may be isolated from them. The cottons are quite up to the required standard for such work, and compare favourably with similar forms grown elsewhere.

As mentioned before, there are a few species and varieties found growing in different parts of the Peninsula: these have been collected and tested, besides, several samples of cotton from them have been submitted by planters for report. The result of the examination shows that there is little likelihood of any of the cottons proving suitable for commercial purposes.

Frequent enquiries have been made concerning the value of the common "chain" or "kidney" cotton (*Gossypium brasiliense*) which is widely distributed in Malaya so that it may be well to give the following extract from "The Commercial Products of India" by Sir George Watt.

"All the nations of the world seem for a time to have vied with each other in the attempt to acclimatise the Brazilian Cotton, and in each new country to which taken it obtained the name of the region from whence immediately conveyed: accordingly in Burma, and also in the Antilles, it is called "Siam Cotton," and in India "Ava Cotton." etc. Roxburgh tells us in the MS. edition of his *Flora Indica* (Preserved in Kew) that he became acquainted with it through seed sent him from Farukhabad. Mr. H. St. George Tucker, Member of the Court of Directors of the East India Company observes that Lady Hastings grew it at Fatteghar, and Roger Hunt, in 1808, addressed the East India Company on the causes of deterioration of Pernambuco and Surinam Cottons. Thus we know that prior to Roxburgh's knowledge of it this plant had been experimentally tried in many parts of India."

"It is, therefore, perhaps not to be wondered at that this cotton has got considerably more widely distributed and is moreover more frequently met with in states of acclimatisation than is the case with any of the other New World cottons. Its large capsule, compact mass of seeds and the copius coating of floss naturally conveyed the impression of great value, and false expectations were raised, only to be rudely dispelled by comparisons of yield to acre. Gradually, however, all interest (or nearly so) in this particular Brazilian Cotton died out with the appearance first of the Upland Georgian Cottons, then the Mexican Cottons, and finally the Sea Island Cottons, all races that could be raised as annuals and occupy the soil for short periods. The present species in most countries accordingly fell into a state of complete neglect and either disappeared or survived as an

escape from cultivation and became "the wild tree cotton" of most popular writers, the properties of which have been the will-o'-the-wisp of nearly each decade for the past century in the world's cotton areas."

The Garo Hill or Assam Indigenous Cotton (*Gossypium arboreum var: assamica*) is another cotton concerning which information has been sought and the following account of it taken from "The Wild and Cultivated Cotton Plants of the World" by Sir George Watt, may be of interest.

"The people of the Garo Hills produce a peculiar kind of blanket, formed of rows of the tufted wool of this plant being placed by hand across the fabric and bound in that position by the weft forced home on each successive row of tufts. Whether that peculiar textile suggested the selection that has resulted in the production of the Garo Hill long-boll cotton it would, of course, be impossible to say. The floss, though abundant, is of little commercial value except, perhaps, to mix with wool."

There are many other types grown in the tropics, such as for example long-staple Upland types, which are far better and which may be worth cultivating.

Caravonica cotton grown from imported seed gave unsatisfactory results. Besides germinating badly, the plants raised were impure and the lint very inferior. If this cotton is given a further trial, seed of better quality must be obtained.

Market Prices of Cotton.

It may be of interest to give the relative values of different classes of cotton in Liverpool on 30th September 1922:—

American Middling Upland	...	12.75	pence	per lb.
Pernambuco Fair ...	...	12.52	,,	,,
Egyptian Sakel ...	...	17.25	,,	,,
West Indian Sea Island	...	23.00	,,	,,
,, ,, Extra Fine		21 to 30	,,	,,

In Ceylon the short-staple Cambodia Cotton is said to have given satisfactory results and a local Cotton Spinning Company recently offered to buy the cotton at the rate of Rs. 20 per cwt. or 2⅔d. per lb.

Summary.

This article shows that long-staple cotton of good average quality can be grown in Malaya with a fair degree of success as compared with the average over a period of years in other cotton-growing countries, provided that its cultivation and the time of sowing are given adequate attention and that pest control is systematised. The best time for sowing the crop would vary in different parts of the Peninsula, calculations being based on the necessity of rain for germinating the seed and the advantages of dry weather during the picking period. The incidence of pests, more particularly the cotton-stainer,

depends somewhat on the presence of other host plants, "Kapok," "Roselle" and "Hibiscus," which would require to be destroyed or the pests found on them controlled in localities likely to be devoted to cotton.

The question of rainfall is not serious since our rains in the growing season are of the nature of showers, though a certain amount of boll-shedding usually results. The extent of this boll-shedding would differentiate between good, average and bad crops in the same way that rainfall effects rice and coconut crops. Experiments indicate that light well-drained loams of average water retaining capacity, well worked up, should give the best results and that steep and stiff land should be avoided. Cultivation must be intensive as opposed to present extensive methods and this point would probably decide the success or otherwise of planting cotton.

In the writers' opinion the eastern and northern states of the Peninsula offer the best prospects for cotton cultivation on account of their more defined wet and dry seasons and their lighter soils.

(Ref. D.A. 2088/22).

OIL FROM STERCULIA SPECIES.

By C. D. V. Georgi.

A sample of seeds, which were a species of Sterculia, was received recently from Kumbang Pasang Estate, Brunei, for examination.

Sterculia seeds are interesting from a chemical point of view, in that they contain two distinct oils, one in the pericarp, the other in the kernel.

It was stated that the seeds are collected by the natives for oil expression, a sample of the native oil, which is used for edible purposes, accompanying the seeds.

Description of Seeds.

The seeds, which were rather mouldy on arrival, were ellipsoid in shape, about 1-1¼ inches long, ⅜-½ inch in diameter and pointed at both ends. They consisted of an outer skin, blackish in colour somewhat resembling the skin of a prune, covering a dark pulpy mass, which adhered to the husk of the kernel. The kernel consisted of a pale green endosperm, apparently consisting of a number of layers packed closely together.

Results of Examination.

The proportions of the various components and the results of their analysis were as follows:—

	per cent.
Proportion of skin and pulp ...	32.9
,, of inner husk	22.6
,, of kernel	44.5
Skin and Pulp.	
Moisture	13.4
Oil (Ether extract)	26.9
Residue (by difference) ...	59.7
Oil (calculated on dry pulp) ...	31.1
Nitrogen (dry oil free residue) ...	2.15
Kernel.	
Moisture	12.4
Oil (Ether extract)	28.9
Residue (by difference) ...	58.7
Oil (calculated on dry kernel) ...	33.0
Nitrogen (dry oil free residue) ...	1.40

Examination of Oil.

Portions of the skin and pulp, also of the kernels, were extracted with ether in order to obtain sufficient of the oils for the determination of the physical and chemical characteristics which are shown in the following table. The figures quoted in Lewkowitsch "Chemical Technology and Analysis of Oils, Fats and Waxes", Fourth Edition, Vol. II, Page 310 and in the Analyst, 1915, Vol. IX, Page 4 by Bolton and Jesson, for oils stated to be from *Sterculia foetida* are added for purposes of comparison.

TABLE SHOWING PHYSICAL AND CHEMICAL CHARACTERISTICS OF STERCULIA OIL.

	Pulp Oil.				Kernel Oil.		
	Extracted with Ether.	Native Expressed.	Figures from Lewkowitsch.[1]	Figures from Bolton and Jesson.	Extracted with Ether.	Figures from Lewkowitsch.	Figures from Bolton and Jesson.
Oil.	Semi-solid (30°C) dark brown, earthy smell.	Yellow liquid, sweetish smell.	...	...	Dark green fat[2], melting about 35°C, sweetish smell.	...	...
Density at 100°C (Water at 15.5°C=1).	.8560	.8614	...	...	.8676	...	...
Refractive Index at 40°C	1.4578	1.4668	...	1.4680[3]	1.4620	...	1.4658[3]
Saponification value ...	191.2	194.6	192.8	...	180.2	173.4	193.8
Iodine value (Wijs) ...	69.7	70.7	58.7	66.3	62.3	81.4	75.8
Acidity (Oleic acid per cent).	74.2	9.0	...	...	10.6	...	...
Unsaponifiable matter (per cent.)	3.7	0.9	...	...	5.6	...	...
Fatty Acids.							
Solidifying point (Titer value).	30-31°C	37°C	...	...	50.3°C	...	...
Iodine value (Wijs) ...	71.7	67.5	...	...	63.3	...	...
Mean Molecular weight...	298.9	289.5	...	...	325.2	...	...

1. Oil extracted with Petroleum Ether.
2. The dark green colour is undoubtedly due to the large quantity of green colouring matter present in the kernels.
3. In original paper in the Analyst the refractive index given in the Zeiss butyro-refractometer scale.

From these results it will be seen that the pulp oil is very acid and that the physical and chemical constants can scarcely be considered representative. The high acidity of the oil is undoubtedly due to the seeds having been packed while still moist. A noteworthy feature of the kernel oil is the high percentage of unsaponifiable matter amounting to 5.6 per cent.

Conclusions.

The results of this investigation show that both the pulp and kernels contain fair proportions of oil, but until greater quantities of the seed are available and representative samples of the oils are obtained, it is difficult to recommend them as useful for any specific purposes.

With regard to the extraction of the oils on a commercial scale it is certain however that the seeds, like African oil palm fruits, would have to be treated immediately after gathering, owing to their soft nature and the consequent liability of the oil to develop acidity. Further, on account of the small size of the seeds and the difficulty of separating satisfactorily the pericarp from the kernel, the husk of the latter being rather thin and fragile, it is thought that the most suitable method to adopt would be the expression of the whole oil, by pressing the seed whole, thereby obtaining a mixture of the pulp and kernel oils. From the results of the analysis it will be seen that the amount of mixed oils which could be thus obtained would be about 26 per cent, calculated on the dry seeds.

Although Sterculia trees are said to be distributed widely throughout the East Indies no information is available as to their growth, the period taken to come to maturity and whether the yield of seed is regular, so that their economic value is at present unknown.

ASH FROM CUTCH MANUFACTURE AS A FERTILISER.

By V. R. Greenstreet.

A sample of the ash from cutch manufacture was recently received from Brunei and analysed in order to determine its value as a fertiliser.

This substance is the residue of the bark of various mangrove trees after the extraction of the tannin (cutch) and the subsequent combustion of the exhausted material.

Description : The ash consisted of a fine white moist alkaline or caustic powder. It contained a few small lumps of carbonaceous and siliceous matter and 96.25 per cent passed through a sieve of 1 mm. mesh.

Results of examination : Analysis of the sifted portion gave the following results :—

	Original Ash Per cent.	Calculated on dried ash Per cent.
Potash (K_2O)	8.2 ...	9.6
Phosphoric Acid (P_2O_5) ...	Nil ...	Nil
Carbon dioxide (CO_2) ...	10.4 ...	4.2
Lime (CaO)	43.2 ...	50.5
Insoluble Silica (SiO_2) ...	1.7 ...	2.0
Iron and Aluminium oxides (Fe_2O_3. Al_2O_3)	6.4 ...	7.5
Magnesia (MgO) ...	0.6 ...	0.7
Sulphuric Acid (SO_3) ...	1.7 ...	2.0
Hygroscopic moisture ...	14.4 ...	—
Combined Water and Organic matter	15.7 ...	18.3

Remarks and Conclusions :—The figures given in the above table show that the ash consists principally of lime and potash in the form of carbonate and hydroxide. Its value as a fertiliser is therefore about half that of quick-lime plus one sixth that of commercial potassium sulphate. The current prices of lime and commercial potassium sulphate are $16 to $18 and $285 per ton respectively and on this basis the total value of the material as a lime and potash fertiliser is about $56 per ton.

Whether it would be profitable to export the ash depends on freight and other charges for handling and packing. It might be remunerative to extract with water (lixiviate) and so prepare a concentrate on which the proportion of freight charges would be correspondingly diminished. This would require evaporating pans. Evaporation may be carried out either by exposing the liquor to the sun or by utilising waste heat from the cutch boiler. The ash should be stored in a dry place to prevent deterioration.

Any enquiries regarding this material should be addressed to the Secretary for Agriculture S.S. & F.M.S. (Ref. D.A. 192/22).

REPORT ON THE WORK OF THE INSPECTION STAFF, JULY TO SEPTEMBER, 1922.

BY F. W. SOUTH.

STAFF.

DURING the first week of August Mr. A. G. G. Ellis, Inspector of Agriculture, Johore, went on vacation leave to Europe and Mr. A. E. C. Doscas, Assistant Agricultural Inspector, Negri Sembilan was seconded to act for him. Mr. W. H. Barnes, Special Field Officer, Kuala Pilah, was appointed to act as Assistant Agricultural Inspector, Negri Sembilan.

ESTATE VISITS.

During the quarter one hundred and thirty visits were paid to estates by the Chief Agricultural Inspector and Assistant Agricultural Inspectors throughout the Peninsula.

DISEASES AND PESTS OF RUBBER.

Pink Disease. (*Corticium salmonicolor*) has been newly reported from one estate in Perak South, and two in Negri Sembilan.

Dry weather which was fairly general during this quarter did much to check this disease in all districts. Routine treatment continued and the situation calls for little comment. Two estates in Perak North were given advice regarding more effective treatment of this disease and followed it with satisfactory results. In Ulu Selangor district a big demonstration of the methods of treating the disease was organised among Asiatic small-holders by the Malay Probationer. There were present 39 Malays including penghulus, and 22 Chinese. It is intended to organise other demonstrations on the same lines in different mukims to maintain attention to the treatment of the disease.

Mouldy Rot. (*Sphaeronema* sp.).—This disease was newly reported on five estates in Negri Sembilan and one estate in Johore.

In Negri Sembilan the position calls for little comment. Routine control work has continued steadily and the disease has as usual been less or more in evidence according as the weather has been dry or wet.

The disease still occurs regularly at Mentakab in Pahang, but there also it is receiving regular treatment.

In Malacca two new areas became infected during September, namely Sungei Rambai and Sebatu. The latter mukim comprises rubber holdings mainly, from 2 acres to as large as 400 acres in extent, and owned mostly by Chinese.

Sungei Rambai is on the Johore boundary. The infected area extends along the Merlimau-Muar Road from the 18th mile to the Kuala Kesang river and penetrates inland for two or three miles. The disease certainly entered from Johore where it has been established for some years. Energetic action is being taken to get these outbreaks under control and to ensure that the disease is properly treated.

The disease reappeared in the wet weather on the estate previously infected between Tampin and Alor Gajah, but is receiving careful treatment.

In Johore, Mouldy Rot was active in Muar, Batu Pahat and Johore Bahru districts. The worst area is the coastal strip from Muar to Batu Pahat. The conditions on the holdings throughout this area are very insanitary and generally bad, so that they are very favourable to the disease. Effective treatment and control are almost impossible in the conditions prevailing and poverty prevents much action from being taken to improve them.

Fomes lignosus.—It was stated in a previous report that investigations by the Assistant Agricultural Inspector, Perak North, showed that a heavy cover of *Centrosema plumieri* provided conditions favourable to the rapid spread of *Fomes lignosus*. Further investigations are now in progress to determine if in these conditions of surface moisture fructifications of the fungus develop after a short period from all, or the great majority of the infected jungle stumps. If it should prove to be the case that fructifications are formed, then a search for such fructifications would appear to provide a ready means of ascertaining definitely the centres of infection and of effectively controlling the disease by dealing with these. The idea is that the fructifications may appear on the jungle stumps before the disease has spread far or been able to do much harm. The examination of stumps to determine if they are infected has proved to be practicable at a reasonable cost.

No other rubber diseases call for special comment.

Coconut Diseases and Pests.

Beetles.—The routine work for control of the Black Beetle and the Red Stripe weevil has continued satisfactorily in all infected areas.

Investigations by the Assistant Agricultural Inspector, Perak North, at Kota near Taiping again proved the harmful effect of insufficiently buried coconut trunks which come to the surface again as the result of wash.

The Assistant Agricultural Inspector, Selangor, visited a Malay holding some acres in extent at Kapar during September, and discovered that beetles were breeding at the base of practically every tree on 5 acres of the holding. It was estimated that there were at least 200 breeding grounds and over 4,500 grubs were destroyed. The trees had been burnt at the base to bring them into bearing.

quickly, and the ash left after the fuel, probably coconut refuse, had been apparently completely burnt and had been heaped up round the trees in order to support and protect the adventitious roots. This discovery may prove of some importance, as these heaps—consisting of very finely powdered ash, with no sign of decaying matter—were absolutely unsuspected by the Malay Inspecting Officer in charge of the district. So far, however, no similar holding has been reported elsewhere in Selangor.

At Jeram Black Beetles were found breeding in Nipa rubbish left by Malays who had been cutting attaps.

In Johore both beetles are prevalent along the west coastal region which is largely cultivated for copra and where there are numberous dead coconut trees, stumps and timber. Destruction of coconut and arecanut palms is common and it is proposed to introduce an Enactment for the preservation of these valuable crops.

"*Manila Beetles.*"—Specimens under this name were forwarded from an estate in Kuala Langat district. The Government Entomologist identified them as *Diocalandra frumenti* a weevil affecting dead tissue only.

Unidentified Disease.—On an estate in Perak North newly opened with dwarf coconuts a fair percentage of the nuts died off after apparently germinating normally. Many of the seedlings had developed a good root system which appeared to be in good condition after the death of the shoot. The Mycologist is investigating the cause of this trouble.

Locusts.—A certain amount of damage is being done to coconuts on the same estate by a species of locust or grass-hopper which appears to be the same as that which attacked padi at Sitiawan in October 1921. Hand picking at night off tree stumps is being adopted as a control measure, as this was found to be effective at Sitiawan.

Pests and Diseases of Padi.

Nymphula depunctalis.—This pest, which did considerable damage last padi season to the bendangs at Matang Road is again very much in evidence. It is also present in bendangs at the 14th mile Batu Kurau road. Both localities are in north Perak. It is also recorded on nurseries at Permatang To Jaya in Province Wellesley. At Matang it was first found breeding on grasses which overhang and grow in the irrigation canals running through the bendangs. An attempt is being made to clear the grass from all canals in the vicinity. For dealing with the pest in the nurseries spraying is being carried out with a decoction of tuba root. A spraying demonstration was given.

Mole crickets. (*Gryllotalpa sp.*) These are doing harm to the bendangs at Bandar in south Perak. The area in question is dry and this is the reason for the attack which is expected to disappear when

rain comes. An effective method of control under dry conditions has not yet been worked out.

Other Pests.—Parnara sp., *Spodoptera pecten* and grasshoppers are recorded from Province Wellesley; *Parnara mathias* from Perak North; and "bena kura" (*Podops coarctata*) from Perak South. These insects have done but little damage.

Rats.—These have as usual been common generally. The Malay cultivators appear to appreciate the barium carbonate which, as stated in my last report, is being distributed at cost price through the agency of District Officers.

Lalang and Blukar.

There is nothing of importance to report under this head.

Water Hyacinth.

The Water Hyacinth gang in Perak North during the first half of June made the usual periodic clearing of certain small portions of State land in the vicinity of Taiping. On 19th June it proceeded to the Sungei Perak where it cleaned up the weed from Kuala Kangsar down to Ayer Mati in the mukim of Bota. It returned to Krian on 30th August. During September the gang was engaged on the Sungei Briah near Alor Pongsu.

In Perak South a tributary of the Perak river was cleared and small patches around Telok Anson were removed. In the coming quarter the Perak river is to be cleared, southward from Bota and also State land around Kampar.

A few small patches were destroyed in Selangor and work has continued steadily with satisfactory results in Negri Sembilan.

Pests and Diseases of Other Crops.

Giant Snails (*Achatina fulica*). The Assistant Agricultural Inspector, Penang and Province Wellesley reports that this pest has undoubtedly decreased in numbers during the quarter. It would appear that its rate of spread is very much less rapid in Province Wellesley than it was found to be in Ceylon. This is possibly due to unsuitable conditions, as the soil at Butterworth is almost pure sand and this undoubtedly forms a strong barrier to the progress of this creature. In Ceylon it was found that wood ashes and sawdust when placed in shallow ditches surrounding plots in vegetable gardens formed an efficient barrier to the passage of these snails.

The presence of the snails has not yet been reported from any new district, nor have they been observed to do any important damage except in European flower gardens. No natural enemies have been observed.

Citrus Pest.—An unidentified fulgorid bug was found in some citrus trees on an Estate in Perak North. A spray was recommended.

Specimens were sent to the Entomologist who stated that the insect had been recorded on candle-nut trees (*Aleurites triloba*) and had been sent to England for identification.

African Oil Palm.—Bud rot has attacked a certain number of trees on an estate in Selangor.

Rats have been very troublesome on the same estate. They appear to be attracted by the strong aniseed smell of the flowers. They live in the palms and eat the fruit at all stages, preferring it to other foods.

Caterpillars of the family Psychidae defoliated Mango, Coconut, Banana and Jambu Mawar plants in a small plot at Batu Gajah.

White Fly is recorded on custard apples on an estate in Perak South.

Mango Stem Borer, Rhytidodera simulans. The larvae of this beetle damaged Mango and Durian trees at Ipoh. All infected branches are being cut out and burnt. The soil round the trees has been thoroughly changkolled and a heavy dressing of manure has been applied.

Grasshoppers, damaged various annual crops on two estates in Pahang. On one estate they were successfully poisoned but this was not practicable on the small holdings adjoining the other estate.

Loranthus sp., etc. Mistletoe is very common on various fruit trees all over Negri Sembilan. Action is being taken to have it removed.

THE AGRICULTURAL POSSIBILITIES OF CAMERON'S HIGHLANDS, PAHANG.

By W. N. Sands.

IN Malaya for several years past the desirability of endeavouring to find areas of land suitable for the extensive production of quinine, tea, and other crops requiring a high altitude, in the tropics, for their successful cultivation has been recognised by Government and the Department of Agriculture. Numerous localities have been suggested for this purpose from time to time, but none appeared to offer as much scope for exploitation as that imperfectly known tract of land in Pahang popularly termed Cameron's Plateau. This area was originally discovered by Mr. William Cameron, Government Surveyor, in 1885. Cameron reported that it was central hill-country, a sort of vortex in the mountains where over a wide area there were gentle slopes and 'pamah' (plateau) land with rounded hills shut in on all sides by loftier ranges. The mean elevation of the vortex he said was 4,500 to 4,750 feet above sea-level by aneroid.

Mr. H. N. Ridley, F.R.S., late Director of the Botanical Gardens, Singapore, visited the upper Bertam district in 1908 and studied the flora of it, but he did not proceed further than Gunong Berembun. On the other hand, Mr. H. C. Robinson and Mr. C. Boden Kloss with whom he travelled proceeded to Gunong Irau and traversed a portion of the Highlands on their way to and from that mountain. Ridley in his account of the flora of the Telom and Batang Padang valleys (Journal, of the Federated Malay States Museums, Vol. IV, No. 1, Dec. 1909) states that at the Telom (Lubo' Tamang) camp and further on towards Gunong Berembun there are patches of perfectly flat ground, low lying and muddy. These are of some size, and rather to the north of Gunong Berembun lies a similar flat area, apparently much more extensive, which is presumably the plateau described many years ago by Cameron and known by his name.

During March 1914, Mr M. Barrowcliff, Assistant Agricultural Chemist, Department of Agriculture, Federated Malay States, explored a portion of the Bertam valley from the Sungei Ringlet to the foot of Gunong Berembun. He made the elevation of the area 3,400 feet by aneroid. His account of this visit was submitted to the late Director of Agriculture on 20th April, 1914, under the title "Report on a Visit to Cameron's Plateau." As will be shown later, the area reported on is not that described by Cameron, but the Lubok Tamang district mentioned by Ridley.

It was with the object of locating and examining the larger highland area that Government directed Mr. H. C. Robinson, Director of Museums, Federated Malay States, to organise an expedition to it. The writer accompanied the party in order to study the agricultural possibilities of the land.

The expedition left Tapah on 19th August and arrived at Jor (1,800 feet) twenty miles distant, the same day. From Jor to Lubok Tamang on the Bertam (3,500 feet) the distance is about 15 miles; this journey was made the next day. The track from Jor leads to the Perak-Pahang divide and crosses it at 4,200 feet. The land to this point is in the Batang Padang district; it is for the most part too steep for profitable cultivation although in various places it is used by the local Sakai as 'ladang' (provision grounds). Beyond the divide, and at elevations of 3,900 down to 3,500 feet along the road trace, there are patches of sloping land which might be used for agricultural purposes provided a road to the Highlands beyond gave access to them. The soil appears to be good and of similar composition to that at Lubok Tamang which will be fully described later, but the situation of the land is not as good as it is closely shut in by high mountains. It is possible, however, that some of the lower land might be worth clearing and planting in connexion with, and as an adjunct to, the Lubok Tamang area. All the land is under high trees, the undergrowth of which is not heavy.

Lubok Tamang District.

This section of the upper Sungei Bertam valley through which the river runs in approximately a north to south direction has been incorrectly termed the Telom, the name of a river about 12 miles to the north, and by others Cameron's Plateau. The area may be said to extend from the mouth of the Sungei Ringlet, a tributary of the Sungei Bertam, to the base of the Robinson Falls at the foot of Gunong Berembun, a distance of nearly 4 miles in a northerly direction with a mean elevation of about 3,500 feet. The main road to Cameron's Highlands would probably run through the whole length of this district from the upper or northern end of which the Highlands are only about a mile away in a direct line, although over a thousand feet higher in elevation.

Several days were spent in the neighbourhood of Lubok Tamang Camp (3,500 feet) and the Sungei Tiga camp at the foot of Gunong Berembun (3,700 feet) about 3 miles up-stream. The whole area may be described as a long narrow river-valley flanked by high hills. The land is covered with fairly heavy jungle almost to the summits of the hills. The undergrowth is thin, with *Pinanga*, *Areca* and *Calamus* palms predominating. In a few places there are Sakai 'ladang' but as the area is very sparsely populated, these are not extensive in size. On one or both sides of the river there are level or gently sloping stretches of land often ¼ to ½ mile in width with good light sandy soil and plenty of humus. In a survey of these made by the late Mr. Hemmy, the total area is shown to be 320 acres. It is possible however, that by terracing certain of the steeper slopes another 200 acres or more might be cultivated. The subsoil is porous so that drainage is satisfactory. In the Sakai 'ladang' a large variety of Annual and Herbaceous plants establish themselves once the forest trees are removed, and this again points to a fertile soil.

The growth of epiphytes such as orchids, ferns and mosses on the tree trunks indicates a humid climate with not necessarily a very

heavy, but rather an abundant and well-distributed rainfall. In the Sakai clearings the humidity of the atmosphere is decreased considerably as a result of letting in sunlight and air; this is in striking contrast to the humid condition of adjoining areas under forest. It may be expected from the central and sheltered position of these lands that the precipitation will be less than 200 inches per annum.

Barrowcliff, when inspecting the land, had in mind the possibility of growing tea, and he gives the following annual rainfall records of some of the tea centres in Northern India.

Assam	Dibrugarh	...	112.11 inches.
Burma valley	Sylhet	..	156.64 ,,
Duars	--Buxa	...	208.61 ,,
Darjeeling	--Hursoong	..	160.65 ,,

In Java the yearly rainfall of the best tea estates ranges from 100 to 220 inches.

The rocks from which the soil is derived consist of granite schists and slates, and as indicated above, the soil is light and rich and the sub-soil porous.

Barrowcliff's analyses of soil taken from a hillside at the upper end of the valley, (analysis 1), and from flat and slightly undulating land (analyses 2 and 3) lower down are as under:

Mechanical Analysis.

		1.	2.	3.
Gravel coarse sand	.	18.2	6.1	35.1
Fine sand	.	25.9	39.4	35.4
Silt	.	19 8	37.2	16.7
Fine silt	...	17.5	6.5	7.1
Clay	..	10.2	6.0	3.7
Humus	...	8.4	4.0	2.0

Chemical Analysis.

		1.	2.	3.
Moisture	...	7.5	4.9	1.85
Organic matter	...	33.7	12.6	9.7
Potash	...	0.145	0.190	0.345
Phosphate	...	0.065	0.063	0.061
Lime	...	0.10	0.01	0.04
Magnesia	...	0.045	0.10	0.02
Nitrogen	...	0.42	0.20	0.154
"Available" Potash	...	0.0177	0.0136	0.0156
"Available" Phosphate		0.0087	0.0109	0.0074

The conclusion Barrowcliff arrived at after discussing and comparing these analyses with some of those of the best tea soils in North-east India was, that they conformed in every respect to the requirements of a good tea soil and that there was no reason apparent why tea of high quality should not be produced. The writer's observations on the characters of the vegetation and soil, together with the further analyses reported on by Mr. V. R. Greenstreet, Assistant Agricultural Chemist, Department of Agriculture, on pages 281-282 support the opinion expressed above.

Although the Lubok Tamang area is relatively small, yet it is well sheltered and possesses a fertile well-drained soil together with a moist climate. There is little likelihood of periods of drought occurring.

The district is quite suitable for tea and perhaps also coffee of the best Arabian and "robusta" types, but it would not be wise to plant coffee on a large scale until observations on trial cultures had been made. The best Arabian types are susceptible to the leaf-disease (*Hemileia vastatrix*) and the elevation might be rather too high for the more resistant "robusta," still *Coffea robusta* thrives fairly well in certain parts of Java at an elevation of 3,400 feet.

The altitude of the area is below the optimum required for *Cinchona Calisaya var: Ledgeriana*—the best quinine-producing species; this tree would be likely to thrive far better on the Highlands above the Robinson Falls. On the other hand, the land is excellent for market-garden produce of various kinds, such as Irish potatoes and other root crops, cabbages, peas and beans, strawberries and tomatoes, but the commercial success of most of these cultures would depend on rapid and cheap transport facilities to market towns.

Florist's flowers such as carnations, roses, hippeastrums, gladioli, tuberoses, dahlias, violets and many other choice annuals and perennials would also thrive here.

Quite noteworthy is the occurrence of several good pasture grasses, for instance, species of *Panicum* and *Paspalum*, and the readiness with which these, and others of known worth, could be established might render it possible to develop areas under fodder grasses to feed live-stock kept for dairy and other purposes.

Mention has been made of the large variety of plants which are to be found growing in the Sakai 'ladang'; among those observed were:—tapioca, sweet-potatoes, yams, millets, Job's tears, maize, pumpkins, musk-ochro, raspberries (*Rubus glomeratus* and *R rosaefolius*) together with weeds and grasses of many kinds. The robust and healthy growth of various species of the Ginger family (*SCITAMINAE*) in this locality shows that suitable conditions exist for cardamons (*Elettaria Cardamomum*), ginger (*Zingiber officinalis*) and other allied spice-producing plants.

Mountain tops on each side of Lubok Tamang Camp, 4,300 and 4,600 feet attitude respectively, were ascended. Heavy tree growth was encountered almost to the summits of these peaks. The conifers,

Dacrydium elatum and *Podocarpus cupressina* were noted here as scattered trees. At the summits and on exposed ridges, the soil is peaty and mossy, and hardy ferns, such as *Gleichenia spp.* and *Dipteris Horsfieldii*, *Nepenthes*, small-leaved *Vaccinums* and Myrtaceous trees form the bulk of the vegetation.

Near the Sungei Tiga Camp is Gunong Terbakar (4,750 feet). This mountain is a striking feature of the district as it is not covered for some considerable distance below its summit with high forest but with scrubby trees, ferns and many small-leaved plants. Ridley remarked (loc: cit) that the highest land he visited was much less xerophytic than is usual at such altitudes in the Peninsula and commented on the fact that he did not find the distinct Myrtaceous trees *Baekea* and *Leptospermum* and the fern *Matonia*. On Gunong Terbakar these were abundant as well as two striking species of pitcher-plants (*Nepenthes spp*:).

On 28th August Gunong Berembun (6,050 feet) was ascended and from the top of this mountain the first view was obtained of a considerable area of flattish and gently sloping land below to the north and west and backed by high mountains. Gunong Berembun is heavily forested almost to its top, where large clumps of the pretty little bamboo (*Bambusa elegans*), striking species of *Aeschynanthus* and orchids occur.

Cameron's Highlands.

The next day the Highlands were found by following the track from the camp at the foot of the mountain up Gunong Berembum for 1,000 feet to a dividing ridge and then bearing off sharply to the west-north-west. In a distance of less than a mile from the divide, and a descent of about 200 feet only, the Bertam was again reached at 4,800 feet and a site for a camp selected on a flat area near the river named 'Tanah Rata.' The following day the expedition moved up to this place and the exploration of what certainly appeared to be Cameron's so called 'plateau' was commenced.

Messrs. Robinson and Scrivenor ascended to Tanah Rata along the Sungei Bertam by the direct route from the Sungei Tiga Camp and discovered the fine falls of that river which are of the "bridal veil" type with a drop of about 850 feet from the south-west edge of the Highlands to the northern end of the Lubok Tamang district in a distance of just over a mile. The importance of this waterfall from an agricultural standpoint may be considerable, should it be found practicable, as seems likely, to develop cheap electrical power from it for driving machinery, heating and lighting purposes.

At a short distance below the point where the track leaves the dividing ridge on Gunong Berembun to Tanah Rata on the Sungei Bertam, the land on each side for a distance of about half a mile is of easy slope, and a fair-sized area could be utilized for quinine and other crops. The soil is a light friable loam with plenty of humus and easily drained. It is rather shut in, however, owing to its nearness to Gunong Berembun and is not as open as the land at Tanah Rata and further on.

From Tanah Rata Camp (4,800 feet) a visit was paid to the head of the Robinson Falls, a short distance below and along the clear slow-running river where it was seen that the mountains closed in on the river at this point and their slopes were too steep for cultivation.

On 1st September, a hill to the West-South-West of Tanah Rata and quite near to the camp was climbed. The height of it was 5,100 feet, or 300 feet above the camp. From the top a fine view was obtained of nearly the whole of the valley land to the north and north-west, and extensive flat and gently sloping areas were observed. At the summit of this hill are large masses of different species of Rhododendron such as are rarely met with in this country. It was due to this feature that the hill was appropriately named Rhododendron Hill.

Practically the whole area of the Highlands is open valley land with rounded hills 200 to 300 feet high dotted about. The mean elevation of the gently sloping and flat land is about 5,000 feet. The surrounding distant mountains are Gunong Berembun (6,050 feet), Batu Brinchang (6,660 feet), Irau (6,920 feet), Rul (5,600 feet), Jasar (5,570 feet) with smaller peaks and high ridges connecting them. Cameron's description of the area is therefore quite correct, but by no stretch of the imagination can it be termed a 'plateau' so that it was agreed to substitute the term 'Highlands' as being a more suitable designation for it.

Leaving Tanah Rata Camp early on 2nd September, a tour of about 4 miles was made to the north-east to a point on the high ridge at 5,600 feet connecting Gunong Batu Brinchang and Gunong Berembun. This ridge forms part of the higher lands dividing the water-sheds of the Sungei Bertam and Sungei Telom. The land with the exception of exposed ridges is covered with tall straight-stemmed trees, among which are species of *Garcinia*, *Gordonia*, *Michelia*, *Saurauja*, *Pyrenaria*, *Quercus* (oak) and *Castanopsis* (chestnut). Conifers are few in number. The writer is not very familiar with the forest trees occurring at this altitude, but from the number of species seen it is likely that a study of them would prove of interest and certainly of value if it is found that good supplies of timber suitable for building and other purposes are available. Although the trees are for the most part of medium-size, still large specimens occur, for instance, an oak which was measured was found to be 12 feet 6 inches in circumference at 3 feet from the ground. From an agricultural point of view this association of many different species of trees of good clean growth affords evidence of a fertile soil and one likely to favour the growth of Cinchona and other hill crops.

Under the trees grow small *Pinanga*, *Areca*, and 'rotan' (*Calamus*) palms, the latter making walking progress difficult on account of their long spiny stems and leaves. Here and there are small open spaces in which the following striking species were noted, the large banana (*Musa truncata*), two ornamental large-flowered begonias, the terrestial orchids, *Calanthe angustifolia* and its yellow variety, a blue salvia (*Scutellaria discolor*), *Sonerilas*, the beautiful yellow balsam (*Impatiens oncidioides*) and the Himalayan violet (*Viola serpens*). Ferns, mosses and lichens are fairly abundant on the tree-stems, but epiphytic orchids

are far fewer, and in less variety, than in the Lubok Tamang district. In places where dead trees had fallen the curious parasitic plants, *Balanophora spp.* were observed. These leafless flowering plants, of which at least three species were seen, attach themselves to roots of forest trees and large lianes, and obtain all their food from their host-plants. The tuberous orange and red-coloured rhizomes of the parasites are of large size and very conspicuous on the ground. It is probable that they are capable of destroying forest trees under local conditions; still they could no doubt be readily eradicated and prevented from damaging estate cultures. Little is known at present concerning their life history and favourite host-plants.

On the journey large stretches of flat and gently sloping land were traversed. The soil which is covered with 3 to 4 inches of humus is for the most part light and derived from granite and quartz. The subsoil generally is porous so that after heavy rain the soil-water readily drains off. In some of the flat low-lying spots the soil is peaty on the surface, but this could be readily improved by drainage.

From Salvia camp 3 miles to the north of Tanah Rata, and just beyond the largest 'pamah,' further examinations were made of sloping and flat areas. A hill to the north-west of this camp, elevation 5,325 feet named Myrtle Hill afforded a magnificent panorama of the south and west portions of these A portion of this valley land was crossed to a large tributary of the Sungei Bertam which drains the slopes of Gunong Jasar and Gunong Ruil. The higher ridges are mossy with malformed trees, the soil, also, is often covered with a thick layer of fibrous peat with rock below. The gnarled appearance of the trees on the exposed ridges and peaks is no doubt due to the wind combined with unfavourable soil. Lower down on the sloping lands the character of the vegetation and soil is similar to that described previously in other parts of the Highlands. On all sides there are large areas capable of being successfully cultivated. Small areas were noted with an undue proportion of organic matter in the soil and others with a fine silt as surface soil, but where the subsoil is porous, as is usually the case, these unfavourable conditions could be readily improved by cultivation and drainage.

Messrs Robinson and Scrivenor who ascended Batu Brinchang (6,660 feet) 3 miles to the north of Salvia camp reported that they passed through, en route, further areas of flat land of an average height of 5,150 feet with good soil and tree growth.

Several soil samples were taken for analysis by the Agricultural Chemist of the Department of Agriculture. The results of the examination of these will be found on pages 281-282 of this Journal. As anticipated they indicate a fertile soil with good physical and chemical characters.

As a result of this preliminary examination of these Highlands which are estimated to have an area of at least 16 square miles, the opinion is expressed that no difficulty would be found in selecting 2,000 acres of gently sloping land for crops such as quinine and tea. The elevation of all the land would be between 4,800 and 5,200 feet.

The extensive river-flats estimated at not less 1,000 acres are not included in this figuree, but portions of these not required for residential purposes might also be used. Further some of the steeper lands could be successfully cultivated. The area has not been surveyed so that it is not possible to give more than the above rough estimate of the cultivable land available.

Judging from the character of the vegetation the rainfall and humidity are high, but in the absence of meteorological records it is most difficult to form a reliable estimate of the former. The whole district is so well sheltered and protected on all sides by high mountains to a considerable depth that the heaviest rains brought by the south-west and north-east monsoons are no doubt precipitated on the western and eastern slopes of the Central Range, and do not frequently reach these Highlands. As suggested in connexion with the Lubok Tamang district, the annual rainfall may be abundant, but not necessarily unduly excessive for hill-cultures such as either Cinchona or tea both of which will thrive in places where the annual precipitation exceeds 200 inches per annum, provided it is well distributed and the soil is satisfactory. The humidity is certainly high at the present time still this would be reduced considerably as the result of extensive clearings.

The climate is cool: from data obtained from Gunong Tahan by the Director of Museums, the maximum day temperature will probably not exceed 75°F and the night temperature 51°F. A mean annual temperature of 64°F is indicated. These temperature ranges are similar to those of highland districts in Java where excellent yields of quinine, tea and market-garden produce are obtained. Frost is not likely to occur at any season.

The expedition left Cameron's Highlands on 7th September and reached Tapah via Lubok Tamang and Jor on 11th September.

General Summary.

The agricultural possibilities of the Lubok Tamang and Cameron's Highland districts in the north western corner of the State of Pahang and comprising the uppermost valleys of the Sungei Bertam and its tributaries are reported on. Information concerning the botanical features, soils and climate of the areas is also included

Lubok Tamang.

Situation.

This district extends in approximately a south to north direction from the Sungei Ringlet, a tributary of the Sungei Bertam, to the Robinson Falls at the foot of Gunong Berembun. The length of it is about 4 miles and the mean elevation 3,500 feet.

An account of this area is given because the main road to Cameron's Highlands would probably traverse the whole length of it, and it could be readily developed in connexion with the opening up of the larger area

Lubok Tamang is about 36 miles distant from Tapah and 24 miles from the completed section of the road from that town.

Area Suitable for Cultivation.

The district may be described as a long narrow river valley well-sheltered by high hills. It has been surveyed in detail and shown to contain 320 acres of river-flats and gently-sloping lands. Further areas, however, could be made available by terracing steeper land and including portions of land along the lower portion of the road trace from the Perak-Pahang divide. Little difficulty should be found in procuring 500 acres or more of cultivable land.

Soil and Climate.

The surface soil is light with plenty of humus. The subsoil is porous and drains well. The physical and chemical composition of the soil are good and equal those of some of the best tea-soils of India and Java.

The climate is cool and humid. The rainfall is no doubt high, but in the absence of records the annual amount and its distribution throughout the year cannot be closely estimated. It is unlikely that the rainfall exceeds 200 inches per annum. No periods of drought need be anticipated.

Crops and Live-Stock.

The area appears to be eminently suitable for tea and market-garden produce, whilst the possibility of growing coffee of the best Arabian and 'robusta' types on a small scale should not be lost sight of. Further details of the crops which may be cultivated are given in previous pages. It is believed that good pasture grasses suitable for live-stock could be readily run. Live-stock for draft, transport and dairy purposes would be most valuable in these mountain districts. In the highland districts of Java, the small pack-horse is extensively employed for the transport of supplies and produce over long distances.

Poultry of various kinds may be expected to thrive here. Fowls are already reared successfully by the Sakai.

An abundant supply of excellent clear river-water is available at all seasons of the year.

In regards to supplies of poultry, milk and vegetables, the district should be self-supporting with the possibility of an exportable surplus of vegetables if rapid and cheap transport facilities to the chief market towns became available.

Labour and Transport.

There are no residents except a few Sakai; these might perhaps be supplemented by others from the upper Batang Padang district and employed in felling and clearing jungle. It would be unwise, however, to reply on these people who would only desire to work, if at all, at

irregular intervals. Practically all the labour required, therefore, would have to be imported. Chinese working under contract might prove useful at the outset, still in the long run Javanese or Indians from mountainous districts in their own countries where Cinchona and Tea are grown would be more suitable in that they would possess knowledge of the work with these and other hill-cultures and more readily adapt themselves to local conditions.

CAMERON'S HIGHLANDS.

Situation.

This area which is situated in the north-western corner of Pahang was originally discoved by Mr. William Cameron, Government Surveyor, in 1885, and comprises 16 square miles or more of open valley land. It is about 41 miles distant from Tapah along the route followed by the expedition. The district is well-sheltered by high mountains from the slopes of which the Sungei Bertam has its source. It is only about a mile away in a direct line from the northern end of the Lubok Tamang area, although over 1,000 feet higher in elevation. It contains large tracts of flat and gently undulating land suitable for cultivation, the elevation of which ranges between 1,800 and 5,200 feet. The configuration of this 'vortex in the mountains' resembles, although on a smaller scale, the famous Pengalengan Highlands of Java where such fine crops of Cinchona and Tea are produced.

Area suitable for Cultivation.

As no topographical survey has been made and only a preliminary investigation of the land was possible, it is difficult to estimate the acreage available for cultivation. It is judged, however, that there are at least 2,000 acres of gently undulating land and 1,000 acres of river-flats which could be utilized, besides, it is reasonable to suppose that additional areas of some of the steeper hill-sides could be terraced and planted. In Java under similar conditions much use is successfully made of steep lands.

Soil and Climate.

The soil which is derived from granitic rocks is for the most part light and friable, with plenty of humus and porous sub-soil. No swamp land with permanent surface-water was seen. Small areas with peaty soil were observed, but these were usually on exposed ridges. On one of the flat areas the top-soil was a rich loam over a sandy substratum. As with the Lubok Tamang soils the analyses of samples taken show good physical and chemical qualities. Most of the area, even where low lying, should drain readily and prove particularly fertile under plantation conditions.

The growth of trees with which the land is completely covered is good and varied. The undergrowth, as is to be expected, is thin owing to the dense overhead shade and the high elevation.

The climate is cool and moist, but it is most difficult to judge, accurately, the range of temperature and average humidity. From the Gunong Tahan records a minimum temperature of 54°F and a

maximum of 75°F with a mean annual temperature of about 61° is indicated. The humidity under the present forest conditions is probably 86%; this of course would decrease considerably when extensive clearings were made.

The rainfall is abundant but not necessarily excessive. Although there are no data available it is not expected, owing to the central and sheltered position of the area, that the early precipitation will exceed 200 inches. The annual rainfull of certain well known Cinchona and tea districts in Java and India ranges from 110 to 230 inches.

The Sungei Bertam and its small tributaries provide an abundant and perennial supply of clear, cool water within easy reach at most points.

Crops.

Cinchona is the crop indicated for this locality. The sloping land alone of these Highlands is believed to be capable of producing, at the 5th year's harvest, dry bark, or crude alkaloid, containing more than three times the quantity of quinine, calculated as quinine sulphate, used annually in this country. It is highly desirable that the requirements of Malaya in respect of quinine, which are estimated at 20,000 lbs. per annum, should be met locally. Very large sums of money are sent out of the country every year to purchase essential quinine salts obtained from bark grown in foreign countries.

As a full account of the Cinchona Industry in Java has been recently published by the writer in the Malayan Agricultural Journal Vol. X, No. 3, 1922, and can be referred to, further details concerning the crop need not be given here. Sufficient it is to add that the conditions for the successful cultivation of Cinchona such as shelter, elevation, soil, temperature, rainfall, appear suitable and in many respects comparable with those of good Cinchona districts in Java.

Several of the remarks concerning tea, market-garden and other produce in the Lubok Tamang area would also apply to these Highlands, but the lower area appears more suitable for those crops. The writer is of opinion, however, that large supplies of food-stuffs could be produced here if necessary for the use of residents at a hill-station.

Labour and Transport.

The labour question is discussed in connexion with the Lubok Tamang district and the observations made apply to both areas. If is estimated that a labour force at the rate of ¼ to ½ unit would be required for each acre opend up and planted.

In the event of Cinchona cultivation being undertaken at some future date, it should be stated that in the recent contract made in the Netherlands East Indies between the Cinchona growers and manufacturers, the latter will now accept crude alkaloid from the growers in the place of dry bark. In the writer's account of the Cinchona Industry in Java (loc; cit) the following paragraph occurs "Some of the large producers consider that they could obtain better prices if they adopted a process devised locally under which it is possible to

extract crude quinine sulphate from wet-bark on estates. The process is not believed to be covered by patent rights, and as far as the writer is aware, it is not yet being worked, because the manufacturers of quinine compounds are not in favour of it. Still there is no doubt that if it could be successfully employed there would be a large saving in the drying, packing, transport and freight charges, all of which are paid by the growers. The freight and transport charges alone would only be about 7 to 8% of those now paid. The cost of manufacture would be far less than the total of the charges given above, especially if the production of this crude sulphate was carried on along co-operative lines." This process if adopted here would have an important bearing on the transport question for it would mean a considerable reduction in the bulk, weight and cost of transporting the produce of the plantations to railway or port.

The question of gaining access to the area by means of road is outside the scope of this article, but judging from the use made of transport animals in the mountainous districts of Java these might perhaps be successfully employed in this district, and if so, the difficulty of transporting supplies to the Highlands and the various products from them to railway or port would be considerably lessened, even if it is not possible for various reasons to complete in the near future the road originally planned and partly constructed, but only a bridal path.

Cost of Clearing and Planting.

The cost of clearing and planting this land at the present time with Cinchona and Tea under the conditions described cannot be estimated, but it may serve a useful purpose, if only as a basis on which to compute the cost, if the following information obtained in Java recently is given, because the rates of pay of coolies there, when converted into terms of Straits Dollars appeared to be similar to those now ruling in Malaya.

The cost of establishing a Cinchona plantation in the Preanger district of Java is from 75 to 106 dollars per acre for average land with an additional outlay for maintenance, supplying, weeding, etc., totalling $45 per acre at the end of three years, when the first small crop of bark may be reaped. Under the total cost are included nurseries, felling, clearing, cultivation, terracing, draining and planting.

Conclusion.

As a result of this preliminary examination of the Lubok Tamang district and Cameron's Highlands from an agricultural standpoint, the opinion is expressed that the areas are suitable for starting certain valuable industries, new to Malaya, under plantation conditions, and that there is every prospect of success attending any efforts that may be made along approved lines.

The cost of opening up a road to these Highlands may not be considered commensurate with the prospective value of the produce likely to be obtained from them, but should the district be found to fulfil the requirements of a large hill-station for residential purposes, then the whole aspect of the matter of cost would be changed, because there appears to be plenty of land available for bungalows, recreation grounds and gardens as well as plantation sites.

REPORT ON THE SOILS OF LUBOK TAMANG AND CAMERON'S HIGHLANDS.

BY V. R. GREENSTREET.

DURING the recent visit of the Assistant Economic Botanist to Lubok Tamang and Cameron's Highlands, the opportunity was taken of obtaining for analysis various samples of soils considered typical of those areas; the present article gives a short description and analysis of the samples taken.

LUBOK TAMANG AREA.

No. 1—Soil from an abandoned Sakai ladang, half a mile south of Gunong Berembun and at an altitude of 3,600 feet. The land is flat and supports a rank growth of "blukar" 12 to 20 feet high. The soil and subsoil are sandy, covered with 2 inches of humus and are very characteristic of this area adjoining the Bertam River.

No. 2—Soil from virgin jungle, one mile south of Gunong Berembun and also at an altitude of 3,600 feet. The land is undulating and about 50 feet above the river. The soil is more loamy than No. 1, has a sandy subsoil and is covered with 2 inches of humus.

CAMERON'S HIGHLANDS.

Nos. 3 & 4—Soil from slightly undulating land under virgin jungle south-west of Myrtle Hill and at an altitude of 5,200 and 5,000 feet respectively. The soil is covered with 3 inches of humus and the subsoil is sandy and of unknown depth.

Nos. 5 & 6—Soil from the east bank of Bertam River under virgin jungle and at an altitude of 4,950 feet. *No. 5* is from undulating land, sandy, covered with 2 inches of humus and with a loose gravelly subsoil; *No. 6* is from flat land, is a loamy soil, with a sandy subsoil and covered with 3 inches of humus.

GENERAL OBSERVATIONS.

All the soils are of the light sandy type and range from gravels to rich sandy loams. They are all derived from the disintegration of granite and are dark-coloured soils, well supplied with plant nutrients. For such open soils the percentage of organic matter and nitrogen is extremely satisfactory. In view of the different altitude of Lubok Tamang and Cameron's Highlands it is convenient to deal with them separately, the former as a potential Tea area and the latter for Cinchona.

LUBOK TAMANG.

Chemical Analysis.

Number.	*1.*	*2.*
	per cent.	per cent.
Potash (K_2O)	.50	.50
Phosphoric acid (P_2O_5)	.10	.13
Nitrogen	.11	.48
Insoluble in mineral acid	90.1	55.6
Lime requirement in tons per acre (acidity) ...	$8\frac{3}{4}$	$8\frac{3}{4}$

Both soils contain a good supply of potash, phosphoric acid and nitrogen. *No. 1* has a very low acidity, is inclined to be gravelly but with regular and very constant rain there is no doubt of its fertility. *No. 2* has a high proportion of nitrogen and organic matter and may be described as a sandy loam. It is well drained and is a very fertile soil. The Mechanical Analysis may be compared with those of some of the best tea soils of Assam and Cachar.

Mechanical Analysis.

Description.	Lubok Tamang.		Dibrugarh. (Assam)		Cachar.	
	1.	*2.*	*a.*	*b.*	*a.*	*b.*
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Gravel and sand	77.6	22.3	26.3	11.4	24.2	13.5
Fine sand ...	6.4	7.4	45.3	13.2	36.4	34.8
Silt ...	3.1	3.8	18.3	81.7	13.6	16.1
Fine silt ...	3.8	21.2	5.7	9.2	17.3	20.5
Clay ...	2.0	17.6	3.1	3.7	6.4	11.5
Organic matter (loss on ignition)	5.9	21.6	...	...	...	...
Moisture ...	1.1	4.2	1.3	0.9	2.2	4.0

The outstanding feature of the Indian tea soils is their porosity and in this respect the soils of Lubok Tamang show great similarity. *No. 1* being rather gravelly would give a smaller production than *No. 2* but would tend to produce tea of a higher quality.

The soils are also eminently suitable for market gardens. *No. 1* is light and sandy and is characteristically warm and dry, *No. 2* containing more clay and organic matter has a greater water-holding capacity. It would therefore produce larger crops of vegetables than *No. 1.*

CAMERON'S HIGHLANDS.

These four soils show a great similarity amongst themselves. They are light sandy loams containing on an average 60% of sand and gravel. There is a good supply of organic matter, nitrogen and potash ; the phosphoric acid is inclined to be low in *Nos. 3, 4 & 5* but there is no marked deficiency.

Chemical Analysis.

Number.	*3.*	*4.*	*5.*	*6*
	per cent.	per cent.	per cent.	per cent.
Potash (K_2O) ...	.53	.18	.55	.69
Phosphoric acid (P_2O_5) ...	.09	.06	.05	.10
Nitrogen ...	.21	.17	.17	.22
Insoluble in mineral acid ...	68.9	77.0	74.7	61.8
Lime requirement acidity (tons per acre) ...	9¾	5¼	6¾	7¼

Experience in Java has shown that efficient drainage is the *sine qua non* of successful cinchona planting. A hard water-logged subsoil tends to prevent root development. Comparison with Java soils shows that the mechanical composition of the soils of Cameron's Highlands leaves nothing to be desired.

Mechanical Analysis.

Number.	Cameron's Highlands. 3.	4.	5.	6.	Pengalengan Highlands, Java. a.	b.	c.	d.
	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.	per cent.
Gravel & sand...	48.0	51.3	59.7	8.0	31.5	28.3	21.4	27.6
Fine sand ...	9.9	11.0	6.2	35.9	43.3	26.8	48.7	44.1
Silt ...	2.2	3.3	2.1	13.6	10.2	14.1	19.5	20.0
Fine silt ...	10.4	15.1	10.4	18.8	6.3	6.3	8.3	4.2
Clay ...	6.0	6.2	7.9	3.3	9.4	9.0	1.0	3.3
Organic matter	17.2	9.5	11.5	15.7	...	...	...	...
Moisture ...	4.5	2.7	2.2	3.3	...	...	...	...

SUMMARY.

Analysis of the soils of Lubok Tamang and Cameron's Highlands shows that they differ greatly from the majority of cultivated Malayan soils. They possess a uniformly open texture without the corresponding diminution in fertility that is so often the case. In addition to possessing a striking resemblance to the best tea and cinchona soils of India and Java, they have all the properties of good market garden soils.

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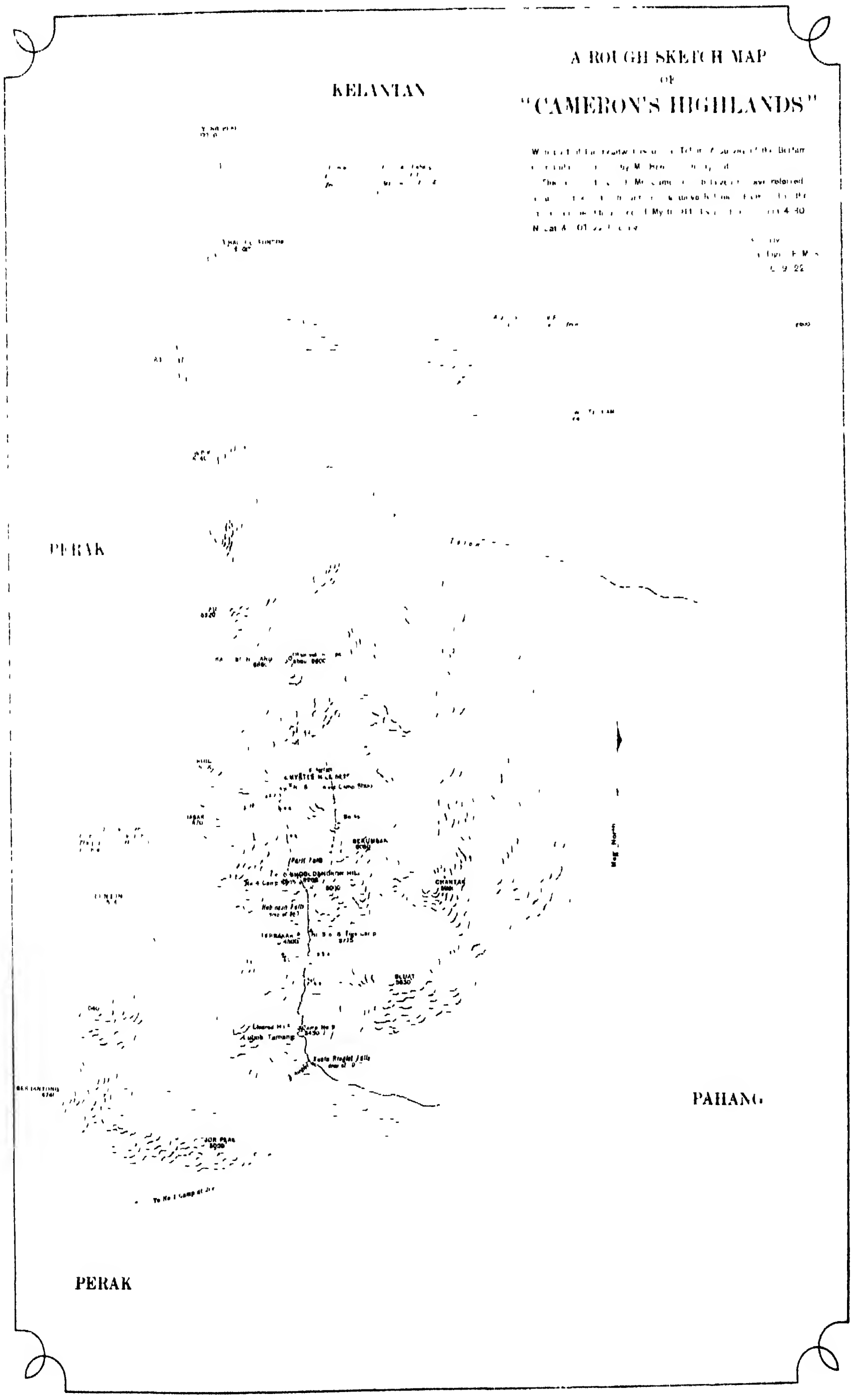
* The annexed sketch map which has been prepared by Mr. J. B. Scrivenor, Government Geologist, shows the situation of the different areas and places mentioned in this and the preceeding article and also the approximate positions of the spots where soil samples were taken.


A ROUGH SKETCH MAP
OF
"CAMERON'S HIGHLANDS"
KELANTAN
PERAK
PAHANG
PERAK

KAPOK OIL.

By C. D. V. George.

WITH reference to the article on Kapok in this Journal Vol. X, No. 2, February 1922 a series of experiments has been carried out recently with regard to the oil which can be extracted from the seed of this tree.

The results of the experiments which included the determination both of the oil content of the seed from different parts of the country and the characteristics of the oil were as follows. -

Oil Content.

The results of analysis of the different samples of seed are given in the following table: -

	Kuala Kangsar.	Lower Perak.	Krian.
Moisture	9.6	13.5	13.3
Oil (Chloroform extract)	22.1	18.6	16.8
Residue (By difference)	68.3	67.9	69.9
Nitrogen	3.33	3.44	3.28
Oil (Calculated on dry seed) ...	24.4	21.5	19.4
Nitrogen (Calculated on dry oil-free residue) ...	4.88	5.07	4.70

A portion of the seed from Kuala Kangsar was also decorticated as follows: -

	per cent
Proportion of husk	43.2
Proportion of kernel	56.8

The Oil content of the kernel, and the nitrogen content of the residue after extraction of the oil were also determined, the results obtained being given in the following table:—

	per cent
Moisture	3.2
Oil (Chloroform extract)	40.0
Residue (By difference)	56.8
Nitrogen (Dry oil-free residue)	10.39
Oil (Calculated on dry kernel)	41.3

Expression of Oil.

In connection with the preparation of the required sample of oil for the determination of the characteristics an experiment was carried

out to ascertain the percentage of oil which could be expressed from the seed using the small laboratory hand-press.

About 4 lbs. of the seed from Kuala Kangsar were crushed between rollers, warmed and pressed, the whole operation being repeated and the residue in the press analysed.

The results were as follows:—

	per cent
Moisture	11.5
Oil (Chloroform extract)	9.0
Residue (By difference)	79.5
Nitrogen	3.08

Assuming therefore that the original seed had an oil content of 22 per cent, it will be seen that about 60 per cent of the oil has been expressed.

The oil was clear, pale yellow in colour, with a sweetish smell. It was noticed that on standing a small amount of "stearin" was deposited.

Characteristics of Oil.

The results of the determination of the characteristics of the oil were as follows (the figures for a previous sample of oil from Kuala Kangsar similarly expressed and exhibited at the Malaya-Borneo Exhibition, Singapore, and also those for Cottonseed oil being given for purposes of comparison) -

	Present Sample Kuala Kangsar	Previous Sample Kuala Kangsar	Average figures for Cottonseed Oil.
Oil.			
Density (15.5°C) ...	.9[illegible]8	918	.923
Refractive Index (20°C)	1.4710	1.4685	
Saponification value ...	197.0	193.3	193
Iodine value (Wijs) ...	94.3	98.1	110
Acidity (Oleic acid per cent)	1.8	26.9	
Unsaponifiable (per cent)	0.8	1.1	0.9
Fatty Acids.			
Solidifying point (Titer value) ..	28.1°C	28.4°C	35°C
Mean molecular weight ..	281.3	292.1	
Iodine value (Wijs) ..	94.2	96.6	

Results of Experiments.

These experiments show that Kapok seed constitutes a valuable bye-product, containing rather more than 20 per cent of oil which is easy of extraction.

The seeds are free from hairs and can therefore be decorticated easily if necessary, in which case the oil content of the kernel amounts to about 40 per cent.

It will be noticed from the analysis of the "previous sample" of oil from Kuala Kangsar, that Kapok oil tends to develop acidity, and care must therefore be taken to ensure that the seed is stored dry.

The cake remaining after the extraction of the oil is rich in albuminoids, 3.98 per cent of nitrogen corresponding to 24.9 per cent of albuminoids.

Possibilities of Kapok Oil.

Kapok oil which, as will be seen from the table above, is closely related to Cottonseed oil is used to a certain extent more particularly in Holland, for edible and soap-making purposes.

It is not a well known oil however, though with the increased demand for the fibre, larger quantities of the seed will be available and, if it can be shipped regularly, its market should widen considerably, especially as the cake forms a valuable feeding stuff.

It is understood that efforts are being made in India to extend the export of Kapok seed for oil expression.* The Indian Kapok seed although derived from a different tree (*Bombax malabaricum*) from the local variety (*Eriodendron anfractuosum*) yields an oil which is similar in all its characteristics, except that its iodine value is less.

The meal from the Indian seed is also of higher nutritive value containing about 36.5 per cent of albuminoids as against 27.3 per cent for the local variety.

* Compare Bulletin Imperial Institute Vol XVIII, 1920, page 335.

NITROGEN LOSSES FROM DUNG AND URINE AND PREVENTION DURING STORAGE.

THE problem of the deterioration of cattle and horse manure under storage is of considerable importance especially now that motor power is being used more extensively in farming practice, involving a decrease in the natural manure available on the spot.

The following conclusions have been published in the Agricultural Journal of India Vol. XVII, No. 4, 1922, by N. V. Joshi as a result of his investigations carried out in India.

(1) The losses from cattle dung when stored either under aerobic or anaerobic conditions are small.

(2) In the storage of urine, large amounts of nitrogen are lost under aerobic conditions and negligible amounts under anaerobic conditions.

(3) If the urine is covered with a layer of oil, *e.g.* kerosene, mustard or coconut oil, anaerobic conditions prevail and the losses of nitrogen during storage are small.

(4) The addition of sulphuric acid, superphosphate or formalin, to urine is also effective in preventing loss of nitrogen but the cost is prohibitive in practice.

(5) If straw or soil is used as an absorbent of urine for purposes of storage large losses of nitrogen occur and these absorbents are therefore of no value.

(6) Greater losses occur in mixtures of cattle dung and urine than when these are stored separately.

Cattle dung and urine should therefore be stored separately and the latter in tanks under anaerobic conditions or in tanks in which the urine is covered with a layer of oil.

It should be understood that even under aerobic conditions the dung should be kept under cover to prevent leaching by rain.

B.J.E.

"WHOLE" RUBBER OR DESICCATED LATEX.

By B. J. Eaton.

THE interest in new types of raw rubber or new methods of preparation is overshadowed at the moment by that which is being taken in new uses for rubber and especially the direct application of liquid latex to the manufacture of paper, impregnation of fabrics, cords for tyres etc.

A new process of preparation of raw rubber however, which has been patented recently, is of considerable interest, although this type of rubber has been prepared by other methods some years ago and is known to be of excellent quality.

It has been known for some years that raw rubber containing all the constituents of latex possesses properties superior to those of ordinary sheet or crepe rubber, both in respect of rate of vulcanisation and tensile qualities.

In Bulletin No. 27 "The Preparation and Vulcanisation of Plantation Para Rubber", published by the Department of Agriculture in 1918, page 78 et. seq., results of tests on such rubber prepared by the evaporation of thin layers of latex in order to retain all the constituents of latex and at the same time to inhibit maturation, are described. It is also shown that this type of rubber has a high nitrogen content and a rapid rate of vulcanisation, whereas "slab" rubber has a low nitrogen content, due to decomposition of protein matter resulting in loss of nitrogen, together with a rapid rate of vulcanisation due to the formation of basic nitrogenous substances from the proteins, which act as vulcanisation accelerators.

It has also been shown in the same publication that the rapidity of cure of "whole" rubber containing all the constituents of the latex is due to vulcanisation accelerators normally present in the serum which are removed more or less completely in the preparation of sheet and crepe rubbers, due to washing and machining the fresh coagulum.

Another point of interest is that the amount of "rubber" prepared from latex by an evaporation or desiccation process is about 5 to 10 per cent greater than the weight of sheet or crepe rubber prepared from an equal volume of similar latex, due to the fact that the non-caoutchouc constituents of the latex are retained and will be included as "rubber" in the final product.

It is also probable that the presence of some or all of the non-caoutchouc constituents of the latex in the rubber improves not only the quality of the vulcanised product but also the keeping qualities of the raw product. This may be a direct or an indirect effect. The non-caoutchouc serum products are hygroscopic and probably absorb sufficient moisture in the final raw product to inhibit or reduce

oxidation processes, which are undoubtedly the cause of the deterioration of sheet and crepe rubber on storage in the presence of air. It is well known that raw rubber can be stored better in a moist atmosphere and our experiments (especially many unpublished data on storage of raw rubber) have shown that "slab" rubber containing from 10 to 20 per cent of moisture can be kept for a long period without deterioration, compared with dry sheet or crepe.

Smoke cured Latex.—It might be mentioned here that Fine Hard Para, Wickham smoke-cured and Derry smoke-cured rubber, which are somewhat similar in character, are essentially evaporated latex, although, as our experiments have shown, the smoking in these processes retards the rate of vulcanisation of the product and is in that respect undesirable.

Fine Hard Para and the imitation products made by the Wickham and Derry processes contain moisture and almost all the constituents of the latex. Wickham and Derry rubber usually contain a small amount of moisture depending on the conditions of treatment, whereas Fine Hard Para usually contains from 15 —20 per cent of moisture.

Quality of "Whole" Rubber.—Apart from the uniformity of Fine Hard Para, in respect of rate of vulcanisation, which has in the past been one of the principal reasons for its preference by manufacturers, it is probable that other desirable qualities are conferred by the non-caoutchouc constituents *e.g.* behaviour of the raw rubber on the mixing and calendering rolls and its value in the preparation of solutions. It also appears to be indicated as more "fool proof" than ordinary sheet and crepe rubber during vulcanisation, which may be due to interaction between the non-caoutchouc constituents and the vulcanising agent —sulphur.

From this it may be reasonably argued that "whole" rubber prepared by the desiccation of latex, without the application of smoke, will possess even better qualities. This is shown in our earlier experiments as well as in recent results given by Hopkinson, the patentee of the new process.

The Kerbosch Process.—Reference might be made also to the Kerbosch process, which was proposed some years ago in Sumatra as a method of preparation of rubber.

This process is described in "Estate Rubber. Its preparation properties and testing" by de Vries (1920) page 486.

The process consists in the desiccation of undiluted latex by means of hot air on the interior surface of a horizontal drum. Another process which, as far as the writer recollects, (no reference can be found at the moment) was proposed by Schadt in The Netherlands East Indies, consists in the evaporation of latex in thin films contained in large shallow trays by means of direct sun heat.

One of the principal reasons why such processes for desiccating latex have not been adopted up to the present, is that the methods of treatment have been too slow to deal with the large volumes of latex

obtained daily under estate conditions. This was the principal reason which led the writer to recommend "slab" rubber, which was assumed to contain not only vulcanisation accelerators formed by maturation of the coagulum (*i.e.* biologically) but also vulcanisation accelerators present in the latex and retained in the coagulum in the preparation of such rubber.

The Hopkinson Process.—The following is a description of the new process which has been patented by Hopkinson.

The latex in the form of a fine jet is fed on to a moving surface and discharged from such surface in the form of fine particles. Such a moving surface is conveniently provided by means of a disc. It is stated that the method allows of close control and produces particles of a uniform size. The rotating disc is mounted in a drying chamber with means for distributing a current of heated gas downwards which comes into contact with the comminuted particles of latex discharged from the disc. An exhaust opening is provided adjacent to the opposite end of the chamber.

The heated gas may consist of air, the products of combustion from a furnace or an inert heated gas such as carbon dioxide, etc.

It is stated that, by the use of the disc, the formation of excessively large or small particles of latex is avoided. The dust-like particles are very minute and light and difficult to recover, necessitaing the use of special condensing or collecting chambers. The hot gases or air for desiccation are preferably at a temperature of over 240°Fah and impinge on the latex particles containing the highest percentage of moisture, thereby preventing "burning" or overheating. By the time the particles reach the floor of the drying chamber, the temperature has been much reduced, due to the heat absorbed by the evaporation of the water from the latex particles. The heated chamber is preferably conical in shape to prevent the tendency of the desiccated particles to deposit on the side walls.

In a description of the original patent it is stated that compounding ingredients or vulcanising agents or both may be added to the latex prior to treatment or subsequently as desired.

By varying the temperature, amount and distribution of the drying medium and size of the spraying disc, its speed of rotation and the flow of latex, the process may be regulated within wide limits to provide products of varying physical characteristics (*Note*:—This appears to suggest that latex can be concentrated to different strengths by varying the conditions).

The particles obtained appear microscopically as transparent spheres of rubber varying in size from 15 to 150μ. The material as collected from the bottom of the chamber is very porous and spongy and if still containing moisture, can be readily dried. The dry spongy product may be compressed into blocks.

The process is said to be simple, efficient and relatively inexpensive compared with an air-spraying process by means of compressed air.

The following figures are given for chemical and physical constants of the products.

Moisture	0.9 per cent.
Extract in water	7.7 ,,
Ash	1.2 ,,

VULCANISED RUBBER (10 PER CENT OF SULPHUR.)

	Tensile strength.	Elongation
Freshly vulcanised product ...	3,900 lbs. per sq. in.	9.7
Product aged for 3 hours at 235° F. in air	3,200 ,, ,,	9.2

The improvement of the vulcanised product over that of ordinary raw rubber is illustrated by the following figures :—

Mixing used. Rubber 100 parts, Zinc oxide 150 parts, Sulphur 10 parts.

Vulcanisation —2 Hours at 40 lbs. steam pressure.

	Ordinary milled rubber.	Sprayed Desiccated latex.
Tensile strength (lbs. per sq. inch) ...	2,000	3,100

Note. —No statement is given as to relative rates of vulcanisation and whether the time of cure in the above experiment was the optimum in both cases.

A subsequent patent includes the addition of ammonia to the latex before treatment in order to inhibit natural coagulation and also the addition of saponin, glycerine or glue and other substances to inhibit premature coagulation when vulcanising agents or compounding ingredients are added to the latex before spraying. In order to prevent natural coagulation the addition of 0.1 per cent of ammonia is recommended and to prevent coagulation on addition of vulcanising agents or compounding ingredients the addition of 0.1 per cent of saponin is proposed.

The latex and ammonia or latex plus compounding ingredients and/or vulcanising agents and saponin are agitated in a tank and, while undergoing agitation, the latex is delivered in a uniform stream to an air jet and projected in a stream of finely divided particles.

The finely divided spray is passed into a chamber where it meets a stream of drying gas, preferably heated air, at about 200°F. The temperature drops to about 180°F due to evaporation of water from the particles of latex. The fine dried particles of latex are led into a tortuous channel and finally deposited in spiral collectors.

The fluid content of the latex may be reduced as desired and the dry product contains about 0.6 per cent of moisture.

The product from pure latex is porous and spongy, with small resiliency and white in colour. As collected from the chamber the product has a density of 0.3—0.4 at 70°F.

The spongy product is converted into a crude rubber mass by treatment in hydraulic presses or by passing between rolls.

The compressed rubber is stated to have a globular structure contrasted with the striated structure of ordinary rubber.

The following figures for chemical analysis of this rubber, compared with those of ordinary milled coagulum, are of interest.

	Moisture per cent.	Acetone extract per cent.	Ash per cent.	Water Extract per cent.	Protein per cent.	Acidity (as acetic acid) per cent.
Ordinary milled rubber	(Below 1)	3.0	0.4	0.5	2.0	0.02
Desiccated sprayed latex	(Below 1)	5.2	1.5	7.2	4.2	0.10

It is stated that the rubber has a neutral or alkaline character as opposed to the acid reaction of ordinary raw rubber. (The figures quoted in the table above for acidity should therefore be probably reversed.)

"Whole" rubber v. Slab rubber.— Whether "slab" rubber prepared from concentrated latex and containing therefore the maximum amount of (*a*) non-caoutchouc constituents of latex, including accelerators present in the latex and (*b*) vulcanisation accelerators produced by maturation, is superior from the manufacturer's point of view to "whole" rubber prepared from latex which has been evaporated or desiccated in a suitable manner, as in the process described in this paper, remains to be proved.

The disadvantages of "slab" rubber are undoubtedly the odour, moisture content and the fact that it is very tough and more difficult to treat on the creping machines. Whole rubber, if properly prepared, can probably be used directly by the manufacturer without further washing or drying.

Further, as indicated in the patent, the incorporation of vulcanising agents and other substances in the latex, before desiccation, thus eliminating the mixing process in the manufacture, is possible.

We have therefore a new process of preparation of a type of rubber which has been prepared on a smaller scale and by less suitable methods previously and a method or process which may eliminate the present method of preparation of sheet and crepe on the estate.

Possibilities of the Process.—The advantages of the process may be described as (*a*) Simplicity of manufacture with a minimum of labour and drying space and the fact that the rubber may be shipped on the day following the collection of the latex.

There may however be difficulties in connection with the spraying apparatus when applied to latex desiccation, which may not have been overcome yet.

(*b*) A product which should be very uniform when prepared from bulked latex, and should therefore appeal to manufacturers.

The factors which will determine the commercial utilisation of the process are (1) cost of manufacture, including cost of transport of latex to central factories. It would appear that the process is well adapted to the erection of co-operative factories for a number of estates, thus eliminating much expense in respect of buildings, plant and overhead charges. (2) Buyers' and manufacturer's prejudices, which will affect the sale. (3) Difficulties in connection with operation of the plant.

It may also be possible to concentrate latex by this process so as not to affect its quality on subsequent dilution, thus enabling a concentrated latex to be exported for purposes such as impregnation of fabric, cords for tyres, etc.

It is of interest to note that the United States Rubber Plantations, Ltd., in Sumatra, which hold the rights of the Hopkinson patent are already preparing this type of rubber.

When the vulcanising agent and compounding ingredients plus saponin are added to the latex before spraying the resistance to abrasion and the tensile strength of the vulcanised material is stated to be still further improved. This is probably due to the elimination of the milling or mixing process, which tends to break down the rubber, and also to an increase in homogeneity of the mass effected by the spraying process.

The increased quantity of protein is also stated to accelerate the vulcanisation. (Note :—This effect is probably wrongly attributed to the protein and is probably due to the inclusion of other natural accelerating agents in the rubber.

It will be seen from the above description that the Hopkinson process appears to consist of a suitable apparatus (apparently similar in many respects to an apparatus previously used for the manufacture of dried milk powder, etc.) for the commercial preparation of a dry rubber by the desiccation or evaporation of latex, producing what may be described, for lack of a better term, as " whole " rubber.

The type of rubber therefore is not new, although the method of preparation is new and appears to meet the requirements of commercial production. It might be mentioned here that the Krause apparatus for the desiccation of milk is claimed to be applicable to the desiccation of latex.

It may be of interest here to remark also that G. S. Whitby (formerly Chemist to the Société Financière et de Caoutchouc, Straits Agency, now Associate Professor of Chemistry at McGill University, Canada) actually discussed such a method of preparation with the writer before he left Malaya in 1917 and suggested the possibility of

utilising an apparatus similar to that used for the manufacture of dried milk powder.

Slab and Whole Rubber.—Before concluding this article, a few remarks on the history and comparison of slab and whole rubber appear desirable.

In researches carried out up to 1918 by the writer and his colleagues, the full details of which are published in Bulletin No. 27. "The Preparation and Vulcanisation of Plantation Para Rubber" (1918) nearly all the experiments described in connection with "slab" rubber were made on latex diluted to contain a dry rubber content of 1.5 lb. per gallon of latex or approximately 15 per cent. As is well known, undiluted latex as collected from the tree varies in its dry rubber content from about 25 to 40 per cent or even beyond these limits, due to various factors, such as method of tapping, soil conditions, age of tree, etc.

In the preparation of smoked sheet rubber in order to obtain a sheet of good appearance, (a false standard required by the market) it is neçessary to dilute latex to a dry rubber content of about 1.5 lbs. per gallon, although the writer has shown that, from the point of view of the intrinsic quality of rubber, concentrated latex is preferable.

For this reason and also in order to eliminate the factor of variation in dilution, all experimental work on slab rubber was carried out by the writer and his colleagues on latex diluted to contain 1.5 lbs. of dry rubber per gallon of latex. In order to show however that in the preparation of slab rubber it was preferable to use the most concentrated latex obtainable, experiments on the effect of concentration of latex on the preparation of slab rubber were carried out and are described in Bulletin No. 27, Section 8, page 172 et seq.

The increase in rate of cure due to increased concentration of latex is indicated clearly in these experiments and is ascribed by the writer to natural vulcanisation accelerators present in the lâtex and retained by the coagulum in the preparation of slab rubber particularly from concentrated latex.

In all recommendations made to estates experimenting with this type of rubber, it has been stated that the highest concentration of latex obtainable under ordinary conditions should be employed, since the question of appearance of the rubber is of no importance, especially in the case of slab.

It is also stated (loc cit) page 370, para 36 that "the effect of concentration on rate of vulcanisation of rubber is probably due principally to the large amount of the natural accelerator already existing in the latex which is retained by the rubber.

It is to be inferred therefore that "slab" rubber prepared from concentrated latex is essentially "whole" rubber containing all or nearly all of the non-caoutchouc constituents of the latex, (some of which may confer other desirable properties on the raw rubber) and also containing other vulcanisation accelerators produced by the biological changes which take place during the maturation of a thick slab or block of fresh coagulum.

THE COMPARATIVE BUOYANCY OF MALAYA AND JAVA KAPOK.

By B. J. Eaton and J. H. Dennett.

THIS report contains the results of investigations which have been carried out, in order to compare samples of Kapok obtained from the Krian and Lower Perak districts of the Federated Malay States with samples of Java Kapok.

Description of Samples.—The following is a description of the various samples under examination :—

Krian Sample.—The sample as received contained the seed and a certain amount of pod which were separated by hand in the laboratory. The sample was dark cream in colour and rather more curled than the Java sample. The ultimate fibre was of similar length to the Java Kapok.

Lower Perak Sample.—The Lower Perak sample was very similar to the Krian sample.

Java Sample.—The Java Kapok, which was purchased locally was a well cleaned sample, free from seeds and pod and dark cream in colour. The fibres were straight, probably due to having been machine cleaned.

A comparison of the buoyancy of the various samples was conducted by methods similar to those described in the Bulletin Imperial Institute Vol. XVII, No. 1. January-March 1919, the main object of the investigation being to test the suitability of the Kapok for use in life-saving apparatus, for which purpose the material is now extensively used.

Analysis of Samples.—The following table shows the results of proximate analysis of the various samples, in respect of the content of moisture and ash in washed and un-washed samples.

The figures given are the mean of several estimations.

	Krian Sample.	Lower Perak Sample	Java Sample.	Java Sample Examined at Imp. Inst.	Indian Sample Examined at Imp. Inst.
	per cent.	per cent.	per cent.	per cent.	per cent.
Moisture (un-washed sample).	9.5	8.23	6.9	9.0	8.1
Ash (Dry un-washed sample).	1.57	1.09	1.16	1.3	4.4
Ash (Dry washed sample).	0.46	0.50	0.92	1.0	2.7

The figures given in the above table show that the Malaya and Java samples examined at the Department of Agriculture are very similar in respect of moisture and ash to the Java sample examined at the Imperial Institute.

British Standard for Kapok.—In connection with the application of Kapok to life-saving apparatus certain standards have been laid down in different countries and the following are those of the Board of Trade (Marine Circular No. 1572. Instructions to Surveyors. Life Jackets April 1916).*

(*a*) Life jackets intended for use by adults must be capable of supporting at least 15 lbs. of iron in fresh water for at least 24 hours.

(*b*) At least 24 ozs. of kapok must be in life belts which derive their buoyancy from that material.

(*c*) The material to be used for the cover must be unglazed unmangled and free from dressing.

* Regulation (*a*) has been amended by Circular No. 1585 (Board of Trade, Marine) to read as follows :—

A life jacket whose buoyancy is derived from Kapok must be capable of supporting at least 20 lbs. of iron after floating in water for 24 hours with a 15 lb. iron weight attached.

It may be remarked here that these regulations do not appear to be sufficiently clear or detailed : *e.g.*, in the amended regulation (*a*) it is not clear whether the life jacket must be capable of supporting 20 lbs. of iron with the 15 lb. iron weight still attached, after the 24 hours test with this latter weight attached, *i.e.*, 35 lbs. after the original 24 hours' test. This would appear to be the case however from our results. Further, nothing is laid down in the above rules as to the shape or size of the life jacket or belt, whereas our experiments have shown considerable variations according to the tightness of packing, the size and shape of the cushions used in the buoyancy tests, together with the method of applying the weights in the test.

It is not stated also whether the 15 lbs. weight attached to the life jacket or cushion during the 24 hours' test is beneath the surface of the water. In our experiments the 3 lb. weight used for the 4 oz. cushions and the 15 lb. weight for the 24 oz. cushions were beneath the water.

Possibly the above rules are only a portion of other regulations prescribing the shape, size etc., of life jackets etc.

In the investigations carried out at the Imperial Institute no indication is given as to (*a*) the size or shape of the cushions used (*b*) whether the weights were placed on top of the cushions or attached below the surface or (*c*) whether the cushions were "rigid".

The results obtained were found to be modified considerably by the size and shape of the cushion employed. Thus, with a more or less rigid cushion, (*i.e.*, a flat cushion supporting a large flat iron weight, so that the shape of cushion was not altered), the results

obtained differed from those obtained by applying the same weight in the form of say a cube, which rested on a small portion of the surface of the cushion and altered the shape of the latter.

The results obtained at the Imperial Institute do not indicate also whether, at the end of 24 hours, the 3 lb. weight attached to the cushion during that period is still attached for the subsequent sinking test or whether the sinking force includes or is independent of the 3 lb. weight or whether it includes the 3 lb. weight corrected for the buoyancy of the water (N.B.:—It has already been pointed out that this is not at all clear in the Board of Trade standard).

The sinking forces given in this report are the weights placed on top of the cushions. In the 24 hour immersion tests the original weight attached during the immersion period was below the surface of the water and remained there throughout the experiment and the subsequent "sinking" force includes this weight less the weight of the water displaced by the attached weight *i.e.*, the "sinking" force is the total dead weight (apart from the weight of the cushion) required to sink the cushion. This applies to both the 4 oz. ond 24 oz. cushions.

Volume Measurements.—It was considered desirable to ascertain any difference in volume of equal weights of the various samples; this was carried out as follows: –

> 50 grammes of Kapok were placed in a wide tall glass cylinder and covered with a glass disc, which was free to slide up and down the cylinder. On the disc was placed a 1000 grm. weight and the Kapok supporting this weight was allowed to settle for two days before its final volume was measured.

The relative volume of equal weight of the various samples were as follows: –

Java sample	...	...	100
Krian sample	...	...	86
Lower Perak sample		...	85.5

The above results indicate that the Java sample would probably prove rather superior in buoyancy to the Malaya samples, which was confirmed in the buoyancy tests.

Buoyancy Tests.—The types of cushions used in the buoyancy tests are shown below and are described as "Rigid", "Non-Rigid" and "Spherical".

The rigid and non-rigid cushions are similar in shape and differ only in the type of weights attached, which affects the final shape of the cushion. The spherical cushion was made of such a size that the Kapok was compressed into half thetvolume occupied in the other types of cushion.

The size of the cushions used for the 4 oz. samples of Kapok were 9⅝ ins. × 13¼ ins.; the covers were made of coarse undressed butter muslin of about 4600 meshes per sq. inch.

In the tests it was found that three successive sinkings of the same cushion did not give identical results and the figures given in the following table are the mean of three sinkings in each test.

Sample.	Sinking force in Ozs. (A) On first immersion.	(B) After 24 hours with 3 lbs. weight attached.	Sinking force in Ozs. (C) Weight of water absorbed after Test B.	(D) After total immersion for 5 days.	(E) Weight of water absorbed after Test D.	Remarks.
Java.	102.3	112.8	2.0			Non-Rigid.
,,	108.8	110.4	2.3			do.
,,	111.0	111 0	...	111	3	Rigid.
,,	103	114.0	1.4			do.
,,	112	...	...			Non-Rigid.
,,	102.5	122	1.4			Rigid.
,,	109.3	...	...			Non-Rigid.
,,	113.6	90	3.9			do.
Mean.	108.4	100	2.2			do.
Krian.	96	104.5	1.5			Non-Rigid.
,,	104.5	109.5	2.0			do.
,,	96	101	2.0			do.
,,	96	95 5	2.0			do.
,,	103.5	113	1.5			do.
,,	98	97	2.0			do.
Mean.	99	103.5	1.8			...
L. Perak.	106.3	110	2.3			Non-Rigid.
,,	114	103.5	...			Rigid.
,,	114.3	104.6	...			do.
,,	95	106	2.0			do.
,,	105.3	...	...			Non-Rigid.
,,	98.6	91	3.7			Rigid.
,,	95.3	106	2.1			do.
Mean.	104.7	103.5	2.0			...
Java.	70.8	68.0	...	60.4	14	Approximately spherical. Kapok compressed.
Krian.	65	66.6	3.5			
L. Perak.	65	67	3.0			

In the case of the samples left under water for five days decomposition of the fibre occurred, evolving a putrid odour, due to the presence of organic nitrogenous matter. The odour resembled that evolved in the retting of various fibres in stagnant water.

The sinking forces (after 24 hours with 15 lbs. of iron attached) for 24 oz. cushions of kapok, calculated from the mean results obtained for the different samples in the above table are as follows :—

Java Kapok	...	...	41.2 lbs.
Krian Kapok	...	...	38.8 ,,
Lower Perak Kapok	...	...	38.8 ,,

The results calculated from the tests carried out on spherical cushions containing the kapok compressed into half the volume are:—

Java Kapok	...	...	25.6 lbs.
Krian Kapok	...	...	25.0 „
Lower Perak Kapok	...	...	25.1 „

It will be seen that, even under the most rigid of the above tests, the Malaya kapok, although slightly inferior to the Java sample is well above the requirements of the Board of Trade Standard.

The above results on 4 oz. cushions, were confirmed by a few tests made on 24 oz. cushions, the following results being obtained:

Weight required to sink Rigid Cushions containing 24 ozs. Kapok.

		Immediately.	After 24 hours with 15 lbs. of Iron attached.
Java Kapok ...	...	40.4 lbs.	41.0 lbs.
Krian „ ...	...	37.2 „	38.2 „
Lower Perak Kapok	...	37.1 „	38.0 „

The following results obtained in tests carried out at the Imperial Institute on behalf of India are given for comparison. (Reference:—Supplement to the "Indian Trade Journal" August 15 1919).

Weights required to sink a bag containig 4 ozs. floss in fresh water.

Sample.	(A) Immediately after immersion.	(B) After 24 hours in water with 40 ozs. iron attached.	(C) Weight of water absorbed after experiment B.	Calculated weight (lbs.) Supported by 24 ozs. of Kapok, after 24 hours immersion with 15 lbs. of iron attached.
	ozs.	ozs.	ozs.	
Commercial Java Kapok.				
(1)	83 } 82.5	87 } 89	3	32.6 } 33.3
(2)	82	91		34.1
Togoland Kapok...	78	78	...	29.3
Indian Kapok ...	99 } 77	97 } 102	3	36.4 } 38.2
Indian "Machine cleaned" in India	107	107		40.1
Akund Flooss	80 } 77	69	14	25.9
Akund "Machine cleaned" in	74			
India	45	...	...	16.9

Note.—The Java and Togoland kapok were derived from *Eriodendron Anfractuosum*, which is similar to Malaya kapok. The Indian kapok was derived from *Bombax sp.* while the Akund floss is derived from *Calotropis sp.*

The following table shows the results obtained on 24 oz. samples and also calculated for 24 oz. samples from the tests on the 4 oz samples.

Samples.	A Immediately after immersion.	B After 24 hours with 15 lbs. of iron attached.	C Weight of water absorbed.	D Further immersion with 15 lbs. of iron attached.		E Weight of water absorbed after experiment. D
	lbs.	lbs.	lbs.	24 hrs.	14 hrs.	lbs.
Commercial Java Kapok 24 oz. sample	30.3	31.5	0.94	19.5	...	10.3
Java Kapok (calculated for 24 ozs. from small scale tests).	30.9	33.5	1.13	...	23.6	8.4
Indian Kapok (24 oz sample).	45.5	42.3	1.0	18.0	...	12.5
Indian Kapok (calculated for 24 oz. sample from small scale test.)	38.6	38.2	1.3	...	21.7	10.6

SUMMARY.

The results of this investigation show that the Malaya samples are only slightly inferior to the Java samples and are well above the Board of Trade Standard.

The results obtained under different conditions of testing indicate also the desirability, in connection with the standards adopted, of laying down a few more details in respect of the conditions under which the tests should be carriedout.

CASHEW NUT OIL.

By C. D. V. Georgi.

A series of experiments with Cashew Nut Oil (Minyak buah janggus) has been carried out recently in view of a suggestion that this oil might be utilised in pharmaceutical preparations in a similar way to Almond Oil.

Cashew nut oil is obtained from the kernels of the fruit of *Anacardium occidentale*, a tree which is found widely distributed throughout tropical regions. In the Malay Peninsula the tree occurs principally in the coastal districts of Pahang and it was from that State that the supplies of nuts for the present investigation were obtained.

Description of Fruit.

The fruit is kidney-shaped, about 1¼ inches long, dark brownish grey in colour and weighs about 5 grams. The shell is hard and leathery on the surface, but cellular in the interior and contains a brownish black oil which is a strong vesicant. The kernel is covered with thin reddish yellow skin, the flesh itself being yellowish white.

It may be mentioned here that the kernels are eaten as a dessert nut, both in countries where the tree grows and also in Europe. Further, they are used in the manufacture of nut chocolate and other sweetmeats, where they are frequently employed as a substitute for almonds.

Oil Content.

The results of the analysis of two samples of the nuts were as follows.

		Per. cent.	Per. cent.
Proportion of husk.	...	30.8	30.8
Proportion of kernel	...	69.2	69.2
Kernel.			
Moisture.	...	9.7	8.1
Oil (Chloroform extract)	...	37.8	33.5
Residue (by difference)	...	52.5	48.1
Oil (on dry kernel)	...	41.9	17.3

Expression of Oil.

In connection with the preparation of the requisite sample of oil for valuation[1], an experiment was carried out to ascertain the percentage of oil which could be expressed by using a small laboratory hand-press.

---

1. The sample of oil has been despatched to the Malay States Information Agency, 88 Cannon Street, London E. C. 4 and the result will be published in due course.

On account of the somewhat slimy nature of the kernels when crushed the latter had to be partly dried before pressing, to prevent contamination of the oil by meal.

The crushed kernels were dried for about three hours at a temperature of about 80° C. and pressed. The operation was repeated and the residue in the press analysed.

The results were as follows.

		Per. cent.
Moisture	...	7.7
Oil (Chloroform extract)		22.5
Residue (by difference)		69.8
Nitrogen	...	3.74

Assuming therefore that the kernels had an oil content of about 43 per cent, it will be seen that only about 50 per cent of oil has been expressed.

The oil was clear, brownish yellow in colour, with a faint smell and a bland taste. There was no deposit on standing.

Characteristics of Oil.

The results of the determination of the physical and chemical constants of the oil were as follows. The figures for Almond oil taken from Lewkowitsch, "Chemical Technology and Analysis of Oils, Fats and Waxes," Fourth Edition, Volume II, page 285 are given for purposes of comparison.

Oil.		Cashew Nut Oil.	Almond oil.
Density at 15.5°C.	...	0.919	0.917-0.919 (15°C)
Refractive Index at 20°C.	...	1.4770	1.4705
Saponification value.	...	187.3	189.5—195.4
Iodine value (Wijs)	...	78.4	93—101.9
Acidity (Oleic Acid per cent)		5.5	
Unsaponifiable (per cent)	...	0.6	
Fatty Acids.			
Solidifying Point (Titer value)		28°C.	9.5 —11.8°C.
Mean Molecular Weight.	...	284.6	

Results of Experiments.

The experiments show that the kernels of the Cashew nuts are rich in oil, containing between 40 and 45 per cent. The nature of the kernel is such that it will require a high pressure to extract the maximum quantity of oil.

The decortication of the nuts is a difficult problem in view of the leathery nature of the shell and the presence of the vesicant liquid.

The cake remaining after the expression of the oil is rich in albuminoids. In the sample obtained from the small laboratory hand-press it amounts to 23.4 per cent of albuminoids, corresponding to 33.4 per cent on the dry oil-free residue.

EXPORT OF PLANTS SEEDS, ETC., TO ENGLAND AND WALES TO SCOTLAND AND TO OTHER COUNTRIES.

(*Vide Gazette No. 84 of 1st December, 1922.*) *No. 6487/22.*

It is notified for information that the Destructive Insects and Pests Order of 1922, which came into force in England and Wales on the first day of July, 1922, revoked the Destructive Insects and Pests Order of 1921. Notification No. 1933, published in the *Gazette* of 2nd December, 1921, and made under the Order of 1921 is hereby cancelled.

The Destructive Insects and Pests Order of 1922 prohibits the landing in England and Wales, from any country other than Scotland, Ireland and the Channel Islands of the following categories of plants, seeds, etc., unless the consignment is accompanied by a certificate of freedom from disease issued at the time of packing and not more than 14 days prior to despatch by a duly authorised official of the country from which it is exported :—

(*a*) all living plants with a persistent woody stem above ground, and parts of the same, except seeds, when in use for propagation such as fruit trees, stocks and stools, forest trees, and ornamental shrubs and grafts, layers and cuttings thereof,

(*b*) all potatoes; and all tubers, bulbs, rhizomes, corms and hop stocks for planting;

(*c*) seeds of onions and of leeks for sowing; and

(*d*) gooseberries.

An Order, the Destructive Insects and Pests (Scotland) Order of 1922, which came into force on the 1st day of August, is in similar terms and requires identical certificates for entry into Scotland.

For entry into England and Wales and into Scotland of these categories of plants, seeds, etc., *by post* a copy of the certificate must be attached to the package: for entry by other means, two copies of the certificate are required; one must travel with the consignment; the other must be produced to the Customs officer at the port of entry. In neither case will the original certificate pass into the Exporter's hands; but it will be sent, after the issue of the required copy or copies, by the inspecting officers to the Horticultural Division of the Ministry of Agriculture and Fisheries.

It is anticipated that an Order similar to those in force in England and Wales and in Scotland will shortly be made by the Ministry of Agriculture, Northern Ireland.

There are other countries which require the production of a certificate of freedom from insect pests or fungus disease, before permitting the importation of living plants or part of plants. Amongst the countries in which such a certificate is necessary or useful are Queensland, Victoria, South Australia, New Zealand, Peru, Ceylon, Mauritius and Algeria.

1. When a certificate is desired by any person desiring to export plants or parts of plants from the Colony to England and Wales, to Scotland, or to any of the other countries mentioned above, application should be made well in advance to the Director of Gardens, Singapore, or the Assistant Curator, Waterfall Gardens, Penang. The application must be made in the Form A below (which will be supplied upon request) or must furnish the information required by the Form, in order that the officers of the Gardens Department may make arrangements for the inspection.

2. Applicants will be asked to bring or to send to the Botanic Gardens, Singapore, or to the Waterfall Gardens, Penang, all small consignments, and when it has been found possible to give a clean certificate, to leave them in the hands of the inspecting officer for despatch. If, however, the applicant wishes to despatch the consignment himself and is personally known to the inspecting officer, he at the descretion of the inspecting officer may be permitted to retain possession of his consignment on giving an undertaking in writing to despatch under the certificate nothing but what has been inspected.

3. Large consignments and such as can only be brought or sent to the Botanic Gardens, Singapore, or the Waterfall Gardens, Penang, with difficulty, will be examined by an inspecting officer at some place to be arranged, and on the giving of a clean certificate after such inspection, the consignor must give an undertaking in writing to despatch under the certificate nothing but what has been inspected.

4. The following fees have been prescribed under the Fees Ordinance, 1881, for inspections made at the Botanic Gardens, Singapore, or at the Waterfall Gardens, Penang:–

		$ c.
(i)	for ispecting a postal packet including the posting of it, the consignor furnishing postal labels and stamps	1 50
(ii)	for inspecting a package weighing less than eleven pounds, including the putting of it on a boat or on a train, the consignor paying the freight from Singapore or Penang	2 00
(iii)	for each additional package weighing less than eleven pounds being part of the same consignment	1 00
(iv)	for inspecting a package of seed or fruit weighing more than eleven pounds or less than one hundredweight including the putting of it on a boat or on a train, the consignor paying the freight from Singapore or Penang	3 00

(v) for each additional package weighing more than eleven pounds and less than one hundredweight, which may form part of the same consignment 1 00

(vi) for inspecting a package of living plants weighing more than eleven pounds and less than one hundredweight at the Gardens, including the putting of it on a train or on a boat, the consignor paying the freight 4 25

(vii) for each additional package weighing more than eleven pounds and less than one hundredweight which may form part of the same consignment 2 00

5. The fee, when an inspection of a consignment is made at any other place than the Gardens, will be at the rate of $2 per hour of the Inspector's time in addition to the cost of his travelling expenses to and from the place of inspection, the minimum fee being $5.

FORM *A*.

APPLICATION FOR A CERTIFICATE OF
FREEDOM FROM INSECT PESTS AND PLANT DISEASES.

Number and Description of packages in consignment... ....
....

Distinguishing Marks... ....

Description of Plants...

Grown at...

Since the date of...

Name and Address of Exporter.....................................
....

Name and Address of Consignee

Name of Vessel..

Date of Shipment..

Port of Shipment..

Port of landing in England and Wales or in Scotland, or elsewhere........................... ....
....

Approximate Date of Landing.................................. ....

Date.............,............Signed...

The particulars contained in Form *A* above have also to be filled in by the shipper on each copy in the Certificate.

Abstract of Meteorological Readings in the various Districts of Malaya for the month of October, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	144.94	80.3	90.22	73.64	16.58	75.1	.774	71.6	75%	...	10.67	5.32
Pahang, Kuala Lipis	...	...	80.9	89.8	70.4	19.5	76.2	...	...	...	...	7.23	2.00
Johore, Johore Bahru	...	...	...	86.48	73.08	...	...	...	...	...	...	11.19	1.84
Singapore, Kandang Kerbau	...	...	82.2	87.8	74.2	...	78.1	.823	...	82.	Calm	10.58	1.73
Malacca, Durian Daun	...	123.	82.	87.	74.	13.	78.	.902	...	83.	N.W.	11.18	2.24
Negri Sembilan, Seremban	...	151.2	79.1	90.4	70.9	19.5	76.2	.863	74.1	85.	N.E.	9.74	1.61
,, Kuala Pilah	...	154.1	81.1	89.1	70.6	18.5	77.6	.876	75.2	82.9	N.E.	6.37	.91
,, Port Dickson	...	148.6	81.6	87.2	73.9	13.3	77.6	.869	75.5	80.8	...	14.74	1.12
Selngor, Kuala Lumpur	...	150.8	81.5	89.4	72.2	17.2	76.6	.823	73.3	76.	S.W.	9.18	2.48
,, Klang	...	...	80.0	84.4	74.2	10.2	76.5	...	...	...	...	15.52	2.44
,, Kuala Selangor	...	...	...	89.6	69.7	19.9	...	...	...	...	..	7.55	1.81
,, Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Telok Anson	...	...	80.69	92.	70.	22.	76.84	.873	...	85.	...	16.63	3.81
,, Ipoh	...	...	80.38	92.	71.	21.	75.98	.840	73.8	82.	...	10.35	2.71
,, Taiping	...	...	80.37	92.	71.	21.	76.26	.850	...	82.	...	23.50	4.33
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	56.02	10.70
,, Parit Buntar	...	...	81.80	92.	71.	21.	77.51	.888	...	83.	...	11.18	2.12
Penang, George Town	...	...	...	...	...	...	...	...	...	...	...	...	...
Kedah, Alor Star	...	...	...	...	...	..	...	...	...	...	...	13.12	2.30
Perlis, Kangar	...	...	...	87.61	73.39	14.22	...	...	...	...	...	14.55	2.88

Abstract of Meteorological Readings in the various Districts of Malaya for the month of November, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	138.33	80.0	87.46	73.90	13.56	75.7	.807	72.8	78%	...	22.28	6.63
Pahang, Kuala Lipis	...	...	80.0	89.5	70.1	19.4	75.8	...	...	...	...	8.51	3.20
Johore, Johore Bahru	...	...	...	87.38	73.68	...	...	...	...	...	...	22.88	3.55
Singapore, Kandang Kerbau	...	...	82.6	87.1	76.8	...	77.9	.910	...	84.	Calm	16.68	4.01
Malacca, Durian Daun	...	115.	82.	86.	74.	12.	78.	.907	...	83.	N.	11.92	1.88
Negri Sembilan, Seremban	...	147.9	79.8	90.1	72.9	17.2	76.7	.855	74.6	84.4	E.	8.10	1.02
,, Kuala Pilah	...	143.3	80.1	86.9	70.6	16.3	77.5	.891	75.7	86.9	...	15.81	2.75
,, Port Dickson		146.0	81.1	86.1	74.1	12.0	77.7	.874	75.2	82.4	...	5.80	1.85
Selangor, Kuala Lumpur	...	150.9	80.1	87.4	73.0	14.4	76.2	.833	73.6	81.3	N.E.	7.98	1.21
,, Klang	...	...	79.7	85.0	74.8	10.2	77 0	...	...	...	...	6.89	1.55
,, Kuala Selangor	...	...	...	89.1	69.1	20.0	...	...	...	...	...	14.51	3.49
,, Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Telok Anson	...	...	80.34	92.	71.	21.	76.80	.876	...	85.	...	6.06	1.10
,, Ipoh	...	...	80.04	93.	72.	21.	75.98	.843	73.73	82.	...	13.97	2.36
,, Taiping	...	...	80.74	91.	72.	19.	76.86	.873	...	85.	...	13.03	2.55
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	57.79	8.18
,, Parit Buntar	...	...	80.93	92.	72.	20.	77.19	.883	...	85.	...	8.26	1.37
Penang, George Town	...	151.	82.9	91.	70.	21.	79.1	.942	72.3	83.8	N.W.	12.97	4.17
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	12.08	2.22
Perlis, Kangar	...	...	...	84.96	72.83	12.13	...	...	...	...	...	6.9	1.76

Abstract of Meteorological Readings in the various Districts of Malaya for the month of December, 1922.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb	Hygrometer. Vapour Tension	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	...	77.1	82.19	73.09	9.09	74.2	.790	72.2	84%	...	41.69	7.23
Pahang, Kuala Lipis	...	...	78.4	86.7	69.5	17.1	75.4	...	...	...	...	11.15	2.44
Johore, Johore Bahru	...	...	...	86.18	73.30	..	...	...	...	...	...	8.49	1.60
Singapore, Kandang Kerbau	1014.4	...	80.9	86.4	75.4	...	78.	.896	...	86.	Calm	8.12	1.47
Malacca, Durian Daun	1017.5	117.	82.	87.	73.	14.	78.	.896	...	82.	N.	6.37	.86
Negri Sembilan, Seremban	...	147.4	80.2	90.6	73.2	17.4	76.8	.857	74.9	83.2	N.E.	10.37	1.63
„ Kuala Pilah	...	141.0	79.1	85.7	69.5	16.2	76.6	.860	74.9	87.5	...	11.37	3.34
„ Port Dickson		149.9	80.9	86.6	74.2	10.4	77.2	.866	74.9	82.3	...	5.12	.11
Selangor, Kuala Lumpur	...	148.8	79.2	86.4	72.2	14.2	76.0	.824	73.3	81.	N.E.	7.19	1.26
„ Klang	...	...	79.3	82.9	73.0	9.9	75.9	...	...	...	...	10.89	2.37
„ Kuala Selangor	...	...	...	89.5	69.9	19.6	...	...	...	...	...	5.68	2.33
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	...	..
Perak, Telok Anson	...	...	79.80	91.	70.	21.	76.28	.836	...	85.	...	7.40	2.32
„ Ipoh	...	...	79.36	92.	70.	22.	75.43	.830	72.90	84.	...	10.62	2.40
„ Taiping	...	...	78.45	91.	70.	21.	75.32	.837	...	86.	...	24.21	2.69
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	67.51	4.68
„ Parit Buntar	...	...	80.03	91.	71.	20.	76.76	.877	...	87.	...	12.95	2.55
Penang, George Town	1008.7	150.	80.6	92.	70.	22.	77.9	.915	72.	87.6	N.	12.04	2.32
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	2.71	.80
Perlis, Kangar	...	...	...	84.25	72.06	12.19	...	...	...	...	...	5.03	1.15

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MALAYAN AGRICULTURAL JOURNAL.

Vol. XI.

JANUARY—DECEMBER, 1923.

KUALA LUMPUR
PRINTED BY HUXLEY, PALMER & Co., Ltd
1924.

THE

Malayan Agricultural Journal.

Vol. XI. January 1923. No. 1.

EDITORIAL.

THE present number of the Malayan Agricultural Journal is devoted to the consideration of the various aspects of kapok production in Malaya. The conclusion is that this crop might with advantage be produced locally under plantation conditions. Kapok plantations already exist in the Philippane Islands, in Siam and Java, but as far as can be ascertained, no estate has published its results, possibly because they are as yet inconclusive. or because they prefer to keep them as "trade secrets".

Kapok production, and in particular, the uses to which the floss may be put, has attracted considerable attention during the last few years, owing largely to the extended use of kapok during the war for filling life belts, ocean jackets etc. There are indications that a gradual increase in kapok would easily be absorbed in the world's market. Recent advice from America is to the effect that manufacturers of mattresses are unable to boom kapok as a filler owing to the difficulty of obtaining supplies. On the other hand, a London broker states that the market there would be adversely influenced by an additional shipment of a thousand tons or so. The Department of Agriculture is in a position to place producers of kapok in direct touch with firms anxious to buy. The latter are of opinion that there is no likelihood of over-production for many years to come.

A recent article in this Journal pointed out the difficulty experienced in the West Indies where considerable damage was occasioned to the cotton crop by reason of the pests of cotton finding a host between the seasons on kapok. Owing to the impossibility of inducing the owners of the kapok trees to harvest their crops it was found necessary to destroy all the kapok trees in cotton growing areas. There is no reason why kapok should be a danger to cotton in this respect if the owners of the kapok trees harvest their crops at the proper time. Malaya is not a cotton growing country. but the possibility must be kept in mind that the day may come when the harvesting of cotton and kapok will have to be controlled, in order that one crop may not prove a host for the pests of the other crop.

The account of kapok given in this Journal is a result of close observation of the trees existing in Malaya, and a comparison of the conditions obtaining here and in other kapok producing countries. The thanks of the Department are due to the authors of numerous books of reference on Kapok, to the Governments of other countries who have placed at our disposal information on the crop; and to the Agent, Malay States Information Agency for making enquiry regarding the position in England; and also to a large number of firms and individuals in various parts of the world who have assisted with information, advice and encouragement.

Finally, we cannot refrain from pointing out one of the greatest advantages of kapok cultivation of the fact that the area under the crop can be used for the cultivation——crops in conjunction with the main crop, by reason of the sparse shade thrown by kapok. And we would lay down our definite recommendation that Malaya is suitable for the profitable production of kapok under plantation conditions.

(KAPOK.)

(By D. H. Grist.)

Botanical.

KAPOK (*Eriodendron anfractuosum* D. C., Syn. *Caiba pentandra* Gartn., *E. pentandrum*, Kurz, var. *Indicum* D. C.) belongs to the family of the *Bombaceae*. It is a tall tree, its columnar stem bearing a sparse top of almost bare branches, extending horizontally, arranged in whorls of three branches each. In young specimens the stems bear short sharp spines, which break off on the older trees. Spininess however, varies in different trees here, and in some cases persists regardless of age. The flowers are borne in groups of two to eight in the axils of the leaves. The flowers, which are stalked, have a green calyx with five short sepals. The corolla protrudes from the calyx and is conspicuous on account of its dimensions* and its colour. The corolla is of a dirty white colour, and consists of five almost free petals, 3-4 centimetres long and 12-14 millimetres broad. The torus is very short, and carries five long stamens which protrude prominently from the corolla. The gynoecium is five-segmented, the septa not extending quite to the top; the style is 2.5-3.5 cms. long and has a slightly lobed stigma.

(The fruit is a long capsule resembling a cucumber (7.5-14 cms. long), the five segments splitting longitudinally and displaying a woolly mass, the true kapok floss, in which the seeds lie completely free. The floss is attached to the wall of the fruit, and consists, according to Greshoff, of elongated endocarp cells. The seeds are numerous, dark brown, bare and pearshaped.)

Little can be said of the varieties of kapok; a systematic research has not yet been undertaken. That a scientific study of the subject is full of promise is indicated by a note of Bley's on "randoe lanang", a form in which the lower branches do not drop off. With an eye to the incidental profit on the harvest, Bley has sown the seed of this form and obtained descendants which, for the most part, appear to possess the desired characteristics.

(Uses.)

(Kapok is used very extensively as a "filler" for mattresses, pillows and other articles of upholstery; and on account of its buoyancy and non-matting qualities, it is superior to almost any other filler.) Its advantages as a filler are pointed out by Mathieu in the following table, giving the comparative weights and costs of various fillers necessary to stuff one average mattress:—

Kapok.	9	kilos	@ 3.50	francs	per	kilo	= 31.50	francs.
Seaweed.	16	,,	@ 0.75	,,	,,	,,	= 12.00	,,
Wool (white carded)	10	,,	@ 3.15	,,	,,	,,	= 31.50	,,
Horse hair	5½	,,	@ 5.15	,,	,,	,,	= 43.07	,,
and wool.	5½	,,	@ 3.15	,,	,,	,,		

* The botanical account given in this place is a free translation from Van Gorkom's Oost-Indische Cultures.

It is seen that kapok more than holds its own in competition with animal fibres, but is more expensive than vegetable fibres. The quality of kapok however is far superior to other vegetable fibres. Kapok which has become hard with much use rapidly regains its excellent qualities when exposed to bright sunlight. It has found extended uses during recent years in life-saving apparatus, buoyancy cushions and ocean jackets. The market for kapok is also likely to expand when its value is better appreciated as a filler for surgical dressings. For this purpose it is said to possess the requisite advantages of lightness, elasticity, dryness and suitability for dry sterilation.

Kapok is very largly used in making "down" quilts. The cost of "eider down" quilts is very considerable, but kapok down is said to be quite as good, being as light and warmer than eider, and of course is very much cheaper.

Comparative Buoyancy values of Malayan and Java Kapok.[1]

Since kapok is used extensively in life saving apparatus—life belts, life jackets etc., for which standards of buoyancy have been fixed in different countries, it was considered desirable to ascertain the value of Malayan Kapok compared with Java Kapok, (the latter being well known on the market and considered a standard product) in respect of its buoyancy.

British Standard for Kapok:—The following are the standards laid down by the Board of Trade (Marine Circular No. 1572 Instructions to Surveyors, Life Jackets April 1916).

(*a*) Life jackets intended for use by adults must be capable of supporting at least 15 lbs. of iron in fresh water for at least 24 hours.[2]

(*b*) At least 24 ozs. of Kapok must be in life belts which derive their buoyancy from that material.

(*c*) The material to be used for the cover must be unglazed unmangled and free from dressing.

A life jacket whose buoyancy is derived from Kapok must be capable of supporting at least 20 lbs. of iron after floating in water for 24 hours with a 15 lb. iron weight attached.

Description of Samples examined:—Two samples of Malayan kapok were received and investigated, one from the Krian district and one from the Lower Perak district. Both samples contained seed and a certain amount of pod which were separated by hand. The fibres were more curled than the Java fibre but the colour and length of ultimate fibre were similar.

---

1 Contributed from the investigations of the Agricultural Chemist, Department of Agriculture F.M.S. and S.S.

2 Regulation (*a*) has been amended by circular No. 1585, (Board of Trade, Marine) to read as follows.

Results of Examination :—A proximate analysis of the samples is given in the table below which includes also samples of Java and Indian Kapok examined at the Imperial Institute :—

	Krian sample.	Lower Perak samples.	Java sample.	Java sample examined at Imperial Institute.	Indian sample examined at Imperial Institute.
	p. cent.	p. cent.	p. cent.	per cent.	per cent.
Moisture (unwasheds) sample).	9.5	8.23	6.9	9.0	8.1
Ash (dry unwashed sample).	1.57	1.09	1.16	1.3	4.4
Ash (dry washed sample).	0.46	0.50	0.92	1.0	2.7

The figures in the above table show that the Malayan samples are very similar to the Java sample in respect of ash and moisture.

Volume Measurements : —A determination of the relative volumes occupied by equal weights of the Malayan and Java Kapok gave the following results : —

Java Kapok	... ...	100
Krian Kapok	... ...	86
Lower Perak Kapok	...	85.5

The above results indicate that the Java sample would probably prove rather superior in buoyancy to the Malayan samples, which was confirmed by the buoyancy tests.

Buoyancy Tests.—The following table shows the results obtained by buoyancy tests :—

Sample.	Sinking force in ozs. (A) On first immersion.	Sinking force in ozs. (B) After 24 hours with 3 lbs. weight attached.	Sinking force in ozs. (C) Weight of water absorbed after Test B.	Remarks.
Java ...	108.4	110	2.2	Mean of tests on rigid and-non rigid cushions.
Krian ...	99	103.5	1.8	
L. Perak ...	104.7	103.5	2.0	
Java ...	70.8	68.0	...	Tests made on approximately spherical cushions with compressed kapok.
Krian ...	65	66.0	3.5	
L. Perak ...	65	67	3.0	

The above table shows the results obtained on three types of cushions, flat rigid, flat non-rigid and spherical.

A "rigid" cushion consisted of a cushion on which a flat weight was placed so that the shape of the cushion was not materially affected.

In the case of the "non-rigid" cushion the weights were concentrated on the centre of the cushion, thus affecting its shape.

The results obtained for the rigid cushions were slightly superior in all cases to those obtained for the non-rigid cushions.

In the case of the spherical cushions, the same weight of kapok was compressed into a spherical cushion of about one half the size of the other cushions. The results on this type of cushion are inferior to those obtained on the flat cushions, but are still above the board of Trade Standard.

The results given are the mean of three successive sinkings, since it was found that each sinking did not give identical results. The covers of the cushions were made of coarse undressed butter muslin of about 4,600 meshes per sq. inch. The flat cushions, containing 4 oz of kapok, measured 9⅝ ins. × 13¼ superficially.

From the above results on 4 oz. cushions, the following sinking forces are calculated for 24 oz. cushions. (After 24 hours with 15 lbs. of iron attached).

	Flat Cushions.	Spherical Cushions.
Java Kapok ...	41.2 lbs.	25.6 lbs.
Krian Kapok ...	38.8 ,,	25.0 ,,
Lower Perak Kapok ...	38.8 ,,	25.1 ,,

The above results were confirmed by a few direct tests on flat rigid 24 oz. cushions, the following results being obtained :—

Sample.	Weight required to sink Cushions immediately.	Weight required after 24 hours with 15 lbs. of iron attached.
	lbs.	lbs.
Java ...	40.4	41.0
Krian ...	37.2	38.2
Lower Perak	37.1	38.0

As will be seen, the above results obtained by direct tests are in close agreement with the calculated results.

Summary.——The results of this investigation show that the Malayan samples are only slightly inferior to the Java samples and are well above the Board of Trade Standard.

The results obtained under different conditions of testing indicate also the desirability, in connection with the standards adopted, of laying down a few details in respect of the conditions under which the tests should be carried out.

Much has been heard from time to time regarding the suitability of kapok for spinning purposes. In 1911 the Germans claimed to have found a method of spinning, but on further tests concluded that it was not a commercial success. More recently, the "Manchester Guardian" pointed out its value in this respect and reported that remarkable yarns and clothes have been produced from kapok at the Agricultural School, Hanoi-Cochin China. Enquiry of the Director of Economic Services, Indo-China elicited the information that kapok had indeed been spun and woven in Indo-China by the natives on hand looms, and samples of the finished cloth, in both blue and red were sent. The kapok has taken the colour fairly well. The cloth is of a thick nature, coarse and not strong. The industry has now died out as no market could be found for the cloth. It seems to the present writer that the fabric is quite unsuited for making garments, but might be of considerable value for the linings of overcoats. Such coats would be very warm, light and practically waterproof.

BY-PRODUCTS.

The kapok tree has been put to various uses in Java. The growing trees are there largely employed as telegraph and telephone poles, and to form boundary fences between properties. The leaves are said to be employed in Java as medicine for stomach troubles. The placentas are generally thrown away but may have a use for stuffing mattresses. It is probably suitable for paper making but unlikely to be available in sufficient supplies.

The report has been current of late that the wood from the Kapok tree is largely used in Ceylon and Malaya for match making. This may possibly be true of Ceylon, but certainly not of Malaya.

Kapok seed is a valuable by product of the industry. The export of seed from Java in 1911 stated in pikuls was as follows:— to England 130,000, France 18,000, Holland 15,000.

(1) "Out of 11,042 tons of Kapok oil exported during the first eight months of the current year (2), 9,880 tons came to Great Britain, 879 tons going to France, 281 tons to Holland, and 2 tons to Singapore. In 1920, of the total 12,575 tons exported, 10,886 tons were sent to Great Britain, and in 1921, 1,146 tons of the 1,151 tons exported were imported by the United Kingdom."

The kapok seed cake resulting from the expression of the oil is a valuable cattle food.

(1) Netherlands Indies Review Vol. 3. No. 7.

(2) 1922.

Kapok Oil.*

Oil Content.

Local kapok seed contains between 19 and 20 per cent of oil, as the following table giving the results of analyses of seed from different parts of the country shows:

	Kuala Kangsar.	Lower Perak.	Krian.
	per cent.	per cent.	per cent.
Moisture ...	9.6	13.5	13.3
Oil ...	22.1	18.6	16.8
Residue (By difference) ...	68.3	67.9	69.9
Nitrogen ...	3.33	3.44	3.28
Oil (Calculated on dry seed) ...	24.4	21.5	19.4
Nitrogen (Calculated on dry oil-free residue) ...	4.88	5.07	4.70

It will be noticed also that the dry residue remaining after the oil extraction is rich in nitrogen, the average of the three determinations being approximately 4.9 per cent, corresponding to 30.6 per cent of albumenoids.

Expression of Oil.

Experiments carried out using a small laboratory hand-press have shown that the oil is easy to express, and that it requires no subsequent treatment beyond filtering before placing on the market. Thus, a sample of the cake remaining from some of the Kuala Kangsar seed which had been warm-pressed twice had an oil content of only 9.0 per cent. Assuming that the original seed had an oil content of 22 per cent (compare table above) it will be seen that about 60 per cent of the oil has been expressed.

The expressed oil was clear, yellow in colour and had a sweetish smell. A certain amount of "stearin" deposited on standing, but this is a feature of the oil.

Characteristics of Oil.

The following table gives the physical and chemical characteristics of kapok oil, expressed from Kuala Kangsar seed, together with those for cottonseed oil to which this oil is closely related.

* Contributed from the investigations of the Agricultural Chemist, Department of Agriculture F.M.S. & S.S.

		Kuala Kangsar Kapok oil.	Average figures for Cottonseed oil.
Oil.			
Density (15.5°C)	...	.918	.923
Refractive index (20°C)	...	1.4710	—
Saponification value	...	191.0	193
Iodine value (Wijs)	...	94.3	110
Acidity (Oleic Acid per cent)	...	1.8	25.9
Unsaponifiable (per cent)	...	0.8	0.9
Fatty Acids.			
Solidifying point (Titer value)		28.4°C	35°C
Mean Molecular weight	...	284.3	—
Iodine value (Wijs)	...	94.2	—

Uses of Oil.

Kapok oil is used to a certain extent, especially in Holland, for edible and soap-making purposes. It is not a well known oil however but as the oil can be used for the same purposes as Cottonseed oil and the cake likewise is a valuable feeding stuff, there is every reason to hope that with larger quantities of seed available and regular shipments coming forward the market for kapok oil will widen considerably.

CLIMATE.

The equable character of the climate of Malaya simplifies the consideration of the problem of the advisability of planting kapok in any particular district. The fact that strongly growing trees may be found in almost any district throughout the Peninsula is sufficient evidence of the adaptability of this plant to local conditions. Kapok is a tropical crop and may be found in all countries at such altitudes as are free from frosts. Generally it may be stated that kapok is suited to the tropical lowlands, and in particular to situations sheltered from strong gales. Although the wood is very brittle and from that point of view the trees are liable to suffer from the effects of wind, yet the small resistance offered by its sparse leaf system and scanty branches, constitute a natural protection against wind. It is only when the tree becomes very large that there is likely to be serious danger from this cause. Serious injury to the crop owing to unusual climatic conditions is illustrated from the following extract(1) concerning the Java crop in 1920.

" The 1920 crop in Java turned out a failure as regards quantity " and quality, owing to the abundant rains which fell in September " and October. The crop is estimated at a third of the " normal one."

The harvesting season in Java is September and October, while in Malaya it is April and May. This fact is of distinct advantage to this country especially in the early stages of establishing the local industry, as of course the demand for kapok is keener, and consequently the prices higher between the Java seasons.

(1) Report on Commerce, Industry and Agriculture in the Netherlands East Indies during 1920.

Normally the kapok tree fruits in the dry season, and but once annually. In a climate such as Malaya, the fruiting season of kapok is apt to be more uncertain than is the case in countries with more definite seasons, and this variation of fruiting season may to affect adversely the quality of the floss unless special care is taken at harvesting time. In Java, the natives collect the kapok almost daily during the fruiting season, picking up the pods when they fall from the tree. In Malaya, the pods should be plucked from the tree as they ripen, for if the Java system is followed the rains and heavy dews may damage the floss to a serious extent.

SOIL.

The kapok tree has a root system very similar to that of its branching, *i.e.* long roots running at right angles to the tap-root. It is therefore of great advantage to plant in friable soils. The finest kapok is produced in Java where it is grown in well-weathered volcanic soil. It is probably due to this fact that the best grade of Java kapok comes from the foothills of the Molriah Mountains of the Samarang Presidency. In the absence of such soil conditions, a good friable loam soil is most desirable. Such a soil will allow easy and active development of the root system. Soils of this description are not uncommonly met with in Malaya, especially along the banks of rivers and in ravines. Soils containing a large amount of humus are also suitable, provided that the drainage of such land is effective. It is observed, for instance, that the land in the Bagan Dato area of Lower Perak and at Jeram in Selangor, consisting of soil of this description produces quick-growing healthy trees.

Whereas it is important that drainage be effective, the occasional flooding of land on which kapok is growing is immaterial; in fact, the Malays on the Perak River assert that such floods are of benefit to the crop, and this statement is borne out by the fact that the kapok trees along the Perak River are the finest seen in the Federated Malay States, and are subject to these conditions,--the land being inundated for a few days in each year during the heavy rains. Laterite and heavy clay soils are to be avoided. Owing to the fact that white ants are attracted to kapok, the crop should not be grown on land newly felled and containing a large amount of timber.

PROPAGATION.

Kapok may be grown either from stem or branch cuttings, or from seed. It is stated that in the Philippine Islands the tree is generally established from cuttings, as this is undoubtedly the easiest method of propagation. This would appear to be an insufficient reason for the adoption of a method, especially when, as in this case, the method carries with it decided objections. Trees grown from cuttings commence bearing about one season ahead of trees grown from seed, but, on the other hand, they are more liable to the attacks of white ants; more apt to suffer in high wind owing to the absence of a tap root; and the normal life of such trees is found (locally) to be considerably less than is the case when the crop is grown from seed. It would appear therefore, that the disadvantages of this system out-weigh the advantages claimed for it.

If it is decided to propagate from cuttings, branch cuttings are the better. Cuttings from two to three year old branches, of about 2-8 inch diameter and 4-6 feet long should be employed. They should be planted out as soon as cut. Stem cuttings are frequently employed by Malays for the construction of fences. Such cuttings are generally about six inches or more in diameter and about six feet in length.

Cuttings should be planted during a rainy season, otherwise the number of supplies necessary may be very large.

The method of establishing the crop from seed is most strongly advocated. This may be effected either by prelimary propagation in a nursery, or by planting "seed-to-stake." In the former case nursery beds, raised about six inches, should be about 4 feet wide, and the seeds planted one foot apart. A light "atap" shade should be provided during the early stages of growth, such shade being reduced as the seedlings grow. The seedlings should be transplanted when they are from eight to ten months old. In lifting, care should be taken to prevent damage to the roots, especially the tap root. The crown is removed, leaving about four feet of stem which should be planted in the field with little delay. Transplanting should be effected, if possible, in rainy weather.

The rapid germination and growth of kapok renders the planting of this crop by the method of "seed-to-stake" a sound undertaking. Furthermore by this method the plants do not receive a check during development, and so are less liable to the attack of white ants. The expenses of establishing the crop by this method are less then when nurseries are employed, as directly the land is cleared, crops other than kapok may be interplanted.

In "seed-to-stake" cultivation, about three seeds should be placed in each hole on land previously lined for planting. At an early stage, say from two to three months from planting, all but one of the seedlings in each hole are to be carefully removed, disturbing the remaining plants as little as possible in the process.

The planting distance for kapok should be 18' × 18' or 20' × 20'. This will allow sufficient space for both root and branch systems. It is observed that with close planting, the branches refuse to overlap and are consequently smaller and produce less fruit. Planting at distances suggested above has the added advantages of permitting subsidiary crops to be cultivated between the rows ; and implements to be employed at less expense and with less liability of injury to the main crop.

Little after-cultivation of kapok is necessary. If other crops are not grown in conjunction with kapok, a circular space of four feet should be kept clean around each plant during the early stages of growth.

If kapok cultivation is to be systematized in Malaya a definite schem e of planting, not only of the primary crop, but of other crops under the kapok must be formulated. It is doubtful whether kapok as a sole crop will ever come into favour, but there can be little doubt

that, grown as a main crop, in conjunction with various other crops, especially if the latter are fibre producing plants. kapok cultivation can be made a great asset to "mixed plantations." The cultivation of crops under kapok is made possible by reason of the few leaves and branches produced by kapok. The shade cast by the trees is therefore small, and for three months of the year nil, so that there is a wide range of plants amongst which a selection may be made. It is reported that in Java, coffee, cacao, pepper and vanilla are used in this connection. The Philippine Islands add to this list maguey (cantala), sisal, henequen and mauritius hemp. From observations made in this country, roselle fibre, sunn hemp, tuba, limes and tobacco should prove successful. The advantage of specialising on fibres as far as is practicable is that much of the machinery necessary for preparation of kapok can be adapted for other fibres. This applies more particularly to the preparation of the commodity for export. It is worthy of note that the Malays on the banks of the Perak River frequently plant limes with kapok as they have found by experience that similar conditions are favourable for the two crops. The most suitable crop may of course vary with local conditions, so that no more precise suggestions than the above can be offered in this place.

It is unlikely that kapok removes any large amount of manurial constituents from the soil, for the actual weight of crop removed from the land is small.

The after cultivation of kapok is not essential, but the plantation is sure to improve with cultivation, and possibly with manuring, and the desiderum can be most economically effected by means of subsidiary crops.

Age of Bearing.

Kapok comes into bearing in about three to four years. In the first year of bearing, about fifty pods per tree may be expected, with a very rapid increase in the yield in each subsequent year, until in about the eighth year the average yield may be 400-600 pods per tree. As no systematic planting of kapok has been undertaken in Malaya, an estimate only is possible based on careful observations on the yield and age of individual trees and small groves of trees. A fair average yield of kapok per tree in Lower Perak would be 400 pods per annum, but individual trees, growing in open spaces unhampered by coconut and durian trees have been noted to give over one thousand pods per tree. If this is possible under native conditions with trees of over thirty years old, similar results should be obtainable at a younger age with trees grown under careful plantation conditions.

The supplying of trees on a kapok plantation is possible at all ages of the plantation, as the seedlings will grow and thrive in the small shade cast by the older trees. This is an important point, because unlike a rubber estate, there need never be spaces left in the area through die-outs on account of white ants or other causes. It allows too, for the replanting of an area when the yield has fallen off through old age of the trees.

The maximum age of the kapok tree is uncertain, depending as it does, very largely on external circumstances. The writer has seen trees of 35-40 years old in full bearing, but at such an age the loss of trees through wind-break and die-back would possibly be large.

Pests and Diseases.

Hitherto, pests and diseases of kapok have caused little inconvenience in this country. This is due in part to the fact that the crop is not cultivated on a larger scale, and possibly because, having been considered an unimportant crop, little note has been made of any such danger. From observations made locally, and drawing largely on the experience of Java and the Philippines, the following notes are compiled to serve as a guide to the pests and diseases which may be causes of loss on kapok plantations.

Pests.

White ants are undoubtedly the most serious pest of kapok. The methods of control usually adopted on rubber estates are familiar to the majority of readers. Exhaustive literature exists and reference is directed to the following publications on this subject: F.M.S. Department of Agriculture, Special Bulletin Nos. 1 and 3. Prevention is better than cure, and it is recommended that the plantation shall be as free of timber as possible, to reduce the number of breeding places.

Dysdercus cingulatus, Fabr., a species similar to the cotton stainer (*D. Suturellus*) attacks the pods, but damage caused by this pest is said to be small.

Helopeltis attacks the pods. It is said to be kept in check by some parasite at present unknown.

Batocera hector and *Alcides leeuwenit*, Heller are mentioned as occasionally being the cause of considerable damage to young trees in Java. The former may be kept in check by hand picking and by stuffing the holes made by the insects with carbon bisulphide on cottonwool. No successful treatment of the latter pest has so far been reported. Monkeys and squirrels do considerable damage to trees in Malaya. The monkeys eat the growing shoots, while the squirrels open half-ripe pods to extract the seed.

Diseases.

Loranthus (*L. Pentandrum*, *L. schutesii* and *L. praelongus*), known to Malays under such names as Dalu api, api api, dalu gajah, are the principal plant-parasites of kapok. Kapok, on account of its deciduous leaves and sparse branching system is an ideal host for this pest which can only thrive with plenty of sunlight and air. The disease is spread by birds which eat the seeds. Seeds rapidly germinate and haustoria penetrate into the bast and wood of the host plant, whence the parasite draws all its nourishment. The damage may be great; the wood dies off owing to the fact that the food supply is cut off, and the whole tree is greatly weakened by the drain on its necessary nourishment.

Trees should be kept free from all parasites. Neglect only is responsible for the rapid spread of Loranthus. If the plantation is regularly inspected and the first signs of the disease removed by cutting, the control is effective.

(Pink disease (*Corticium salmonicolor*) has been known to attack kapok. Leaf spot (Ramularia Eriodendri Rae) and an unidentified disease the symptoms of which are bleeding at the base of the trunk are reported as the occasional cause of damage in kapok plantations.)

(HARVESTINE.)

The harvesting of kapok calls for no skilled labour and little expense. "Kapok is largely grown in Java by the natives who "collect the kapok down almost daily as the pods drop from the trees, "thus every few weeks a small quantity, varying from 25 to 50 lbs. is "accumulated.....................the collecting is done by his children, so that all he has to do is to carry this accumulation to the village "stores". Abstract from "Memorandum respecting organization in Java for collecting and marketing kapok grown in native homesteads;" prepared by the British Commercial Agent for the Netherlands East Indies.

On the other hand, "The Literary Digest" for May 6th 1922 describes the harvesting of kapok in Java as follows:— "The "natives sally forth with great poles of bamboo with which they bring "down the long pods.............................Agile Javanese climb "aloft into the branches".

The above are rather conflicting statements; the probability is that both methods are in vogue, the former at such times as the weather is exceptionally dry; the latter when the weather is unsettled, and the floss might be damaged through water.

In the careful harvesting and grading of the crop lies the possibility of establishing an industry in kapok. (On ripening, the green pods containing floss and seed wither and become dark brown. The pod then opens from the top. In damp weather especially, the pod will persist on the tree in a half-open condition; and frequently too, while the pod persists, the kapok is liberated. In any case the kapok is either lost or damaged by rain. Discolouration through dampness originates in the first place from the seed, and secondly by reason of fungus or fermentation. Prevention of loss of crop from these causes can be attained by plucking the pods as they ripen. The harvester, provided with a bamboo, to the end of which is affixed a curved knife, plucks all pods which are turning or have become brown in colour. When the trees are old the worker cannot have sufficient command over the bamboo to harvest from the ground. He is therefore provided with a shorter bamboo and climbs the tree, from which point of vantage he commands a clear view of the pods, and can select those in a suitable condition for harvesting.)

Immature pods produce a floss lacking the lustre of perfectly ripe kapok, and with less desirable characters; overripe pods produce floss of poor colour (often distinctly discoloured). Any unripe pods harvested should be spread out to dry in the sun, with further drying after

the husks are removed. It is strongly advised that kapok be kept in three grades, and sold as such viz. No. 1 quality (from ripe pods) No. 2 quality (from unripe pods), No. 3 quality-(damaged).

Kapok produces one crop per annum. At harvesting time the tree is without leaves, which much facilitates the work. The harvesting season varies slightly in different parts of the country. In general, it may be said to follow the season of greatest rain. In most districts harvesting commences about April. The pods do not ripen together, so that the season is carried through about three months.

Preparation prior to Ginning.

As soon as the pods are gathered and graded as described above, they should be placed on a cement floor in the sun to dry. Children may be employed in removing the outside husk and placentas, both of which are useless. A proportion of the seed can be shaken out at the same time, or this may be made a subsequent operation.

GINNING.

"It is essential that kapok be put on the market in a clean condition, that is, free from seed. Colour does not matter so much, but cleanliness is all-important. Kapok has replaced feathers to a large extent because of the difficulty in cleaning the latter." This is a statement by a broker of Mincing Lane. If kapok is to hold its own, and in particular, if Malayan kapok is to gain a name for itself in the world's market, care must be taken to ensure that the Kapok as exported is clean or, as the same authority goes on to say " if cleanlines could not be assured it is better to ship the stuff without description as simply " kapok " and it would be sold by sample. It would be better to do this than to declare it as cleaned and then for the purchaser to find it not really clean and demand an arbitration."

The consideration of ginning is therefore all important and so is discussed in this place in more detail than are other aspects of the production of kapok.

The separation of the seed from the floss is relatively easy, as the former do not adhere to the latter; kapok may therefore be cleaned by hand picking or by a simple hand machine, or by special kapok ginning machinery.

A simple machine may be constructed in the following manner. A barrel or tub, with the top removed and the bottom perforated, is provided with a vertical beam, fixed in a socket at the bottom and passing through a hole in a brace at the top of the tub. This vertical rod should be able to revolve with ease. The rod projects about two feet from the top of the barrel. From the rod, below the level of the top of the barrel, project at regular intervals at right angles to the rod, two rows of arms, placed opposite, and of such a length that they do not quite touch the sides of the barrel. From the sides of the barrel, projected inwards, are four rows of arms, placed opposite and in such a position that in revolving the beam the arms of the latter alternate with the arms of the barrel.

Round the upper part of the vertical rod is twisted once a length of rope of several yards in length. Two men are stationed on opposite

sides of the barrel, facing one another, and alternately pull the rope, while a third men feeds kapok previously freed of husk and placentas, into the barrel. Thus the kapok is caught between the rapidly revolving arms and the stationery arms, causing it to be opened up and freed of its seed, which falls through the perforations at the bottom of the barrel.

The Malays sometimes employ a rather similar method to the above. The kapok is placed in an open receptacle and a forked bamboo is caused to revolve in the kapok by chafing the stick between the palms of the hands.

Another simple method of freeing kapok of its seed is to place it on a wire frame placed about two feet from the ground and beating the floss with sticks The seed falls through the mesh and the floss is then removed. This method is apt to break up the floss thus lowering its value, and for this reason is not recommended.

The chief objections to these hand methods is that they are generally only effective under close supervision.

The following method described to the writer, of the method employed in treating kapok at a Chinese "fabrik" at Cheribon, Java is of interest. The owner in question stated that the machinery used was invented by his father many years ago, which goes to prove that a fine grade kapok can be prepared by primitive machinery. At this factory the kapok received with husk goes through the following four processes.

First Process.—The pods are picked by hand, one person so treating 2,000 pods por diem. 12,000-13,000 such pods go to the making of one pikul of clean floss. The husks are used as firing; the placentas as a mattress filler, while the seed is crushed for oil. During this process the kapok is graded.

Second Precess.—Sifting of the floss by hand for the extraction of seed. The pods are placed on a wire frame placed in a box and gently stirred with the hands. By this process 25% of the seed is extracted. A great point appears to be made of the fact that up to this point the fibre has not been dried.

Third Process.—The partly-seed-extracted floss from the second process, which is in a "lumpy" condition is placed on a concrete floor enclosed in wire netting. It is dried in this way by exposure to the sun for at least five hours. The presence of a gentle wind is of advantage. Workers turn the floss at intervals in order to expose a new surface to the sun's rays. During this pocess 15% of the seed is extracted.

Fourth Process.—Consists of fine cleaning and lump elimination. The fibre is placed in a revolving cylinder open at either end, and a current of air created by a fan driven through. In this way, the floss loosened from the mass by the revolving cylinder is blown through the further end of the cylinder into a perfectly clean room, where it settles, and later is removed and packed. The seeds and dust remain in the cylinder.

The cylinder in question is said to be about four feet in diameter and twelve feet long.

In this factory 95% of the floss produced is first class quality and 5% of second quality.

The following machinery is in use for the ginning of kapok :—

The Bley Machine invented by Mr. G. Bley, a prominent kapok planter of Java. The machine was exhibited and operated at the Surabaya Fibre Congress and Exhibition 1910 and obtained first prize. The machine is made by Messrs. Lindeteves Stockvis of Batavia and Samarang. It has a capacity of 3 – 3½ pikuls per hour if the kapok is sundried, and requires one horse power to drive the machine at a rate of 500/600 revolutions per minute. The price of the machine was quoted in August 1922 at fl. 980. The Bley machine is said to be one of the best on the market. The following are the particulars of this machine.

The Bley Machine consists of a horizontal, cylindrical, wooden drum, the bottom being of ½" mesh wire-netting, through which a square-section steel axle is fitted in self-lubricating bearings, with a number of vanes or beaters set spirally on each face of the axle. These beaters are fixed at an angle, like the blades of a propeller, and by imparting a screwing motion, draw the kapok through the machine. The last pair of beaters, near the outlet, are set in the opposite direction to avoid choking the outlet. Opposite the outlet are two large fan-like blades, set in the same plane as the axle. These create an air-blast, which expels the cleaned kapok.

Into the walls of the drum, between the beaters, iron pins are driven, and round-section pins may also be fitted on the axle opposite the beaters. The best number of such pins must be determined experimentally, as too many will cause the fibre to break, and the product will be poor and stringy.

Probably the axle, bearings and beaters could be obtained separately from the makers: the drum could easily be constructed on the spot.

This machine can be worked by hand, but owing to the irregularity of this method, power is necessary to produce the best quality kapok.

A detailed description, with drawings, may be found in "Kapok: Culture are Bereiding," published (in Dutch) by the Nederlandsch-Indisch Landbouw-Syndicaat, Soerabaia.

It is recommended that the machine be installed, where possible, in an upper storey. The seeds can be allowed to fall down a shoot to the lower floor, thus overcoming the risk of their mixing with the cleaned kapok. The power would also be installed below, so that the driving-belt is not in the way. It is a somewhat curious fact that although the publication of the Bureau of Agriculture, Manila; "The Kapok Industry" describes several machines for the cleaning of kapok, yet the Director of Agriculture for the Philippines in a recent letter states; "We have been unable to learn of the successful operation of any kapok machine operated for commercial purposes in the Philippines," and that no such machine is obtainable at present in that

country. On the other hand, machinery is commonly (although not exclusively) used for ginning kapok in the Dutch East Indies, and of such machines, the Director of the Division of Commerce, Buitenzorg particularly mentions the Bley machine. The machine has been in use on some Batavia Estates for many years, so it may be presumed that it is satisfactory.

Mr. Saleeby in The "Kapok Industry" gives particulars of the following two machines regarding which he has any information of importance.

"The Becker Machine invented by Messrs. Becker & Co. "Surabaya, Java This machine works on the general principle of "the Bley machine, differing from the latter principally in having the "cleaning chamber set perpendicularly instead of horizontally as in "the Bley Machine, and in its operation and construction being per-"haps a little more complicated than the latter. It is claimed that "this machine cleans about 120 kilos of kapok floss per hour" It requires 3 horse power to drive.

For the Becker machine it is said that the kapok requires no preliminary drying before treatment in the ginner.

"The Lienau Machine...........is built on a very much smaller "scale than the latter and is not provided with a fan. It requires "from one-half to one horse power for its operation, and will clean "between 120 and 130 kilos per day of ten hours. Its simplicity of "construction, the inexpensiveness of its operation, and its low cost "would indicate that it can be operated to advantage on small planta-"tions.""

Mr. E. Lehman, Engineer, Manchester, is the maker of a cotton ginner, the particulars of which are given in his catalogue (1922) as follows :—

"These machines are specially constructed to liberate the cotton from the seed, and are adopted for small or large plantations.

They will gin East and West Indian Cotton, China, Central and South American, East and West Africa, Pacific Island Cotton, and are also adapted for ginning Kapok or Java Silk Cotton.

They are also specially constructed for transport in hilly countries.

I make them in sizes from 12 inches wide to 49 inches wide.

The 12 inch machine is for Hand Power, and the other sizes Belt Power.

The Hand Machine will produce about 21 lbs. of Clean Cotton per hour, according to class : a 43 inch machine, driven by Belt Power, will produce about 1,200 lbs. of Cleaned Cotton per day, the power required being very little, not more than 1 h.p."

"PRICES AND PARTICULARS."

Cotton gin No.	Width.	Weight.	Space Occupied.	Price.
A	12 ins.	300 lbs.	1.06 by 0.9 mtrs.	£60
B	18 „	400 „	1.2 „ 0.9 „	£65
C	24 „	500 „	1.35 „ 0.9 „	£68
D	30 „	580 „	1.50 „ 0.9 „	&74
E	36 „	650 „	1.65 „ 0.9 „	£83
F	48 „	800 „	1.8 „ 0.9 „	£92

Bley also describes in "Kapok : Culture en Bereidung" two other machines.

The Gajamprit Machine.—This consists of a vertical drum and axle fitted with round, wrought-iron beaters, wrought-iron pins being also fixed in the wall, as in the Bley machine. An air-blast is provided by a fan at the bottom, which blows out the cleaned kapok through a wide pipe at the top. The heavy seeds fall through an opening at the bottom.

Hk. Jonker en Zoon's Machine.—This is a more complicated machine requiring 4 h.p. to drive at 400-600 r.p.m. About 600 kg. (about 9¾ piculs) per day of 10 hours is the capacity.

In consists of two separate drums, connected by a pipe. The first drum, which is horizontal, is steam-jacketed and the kapok passes, thence to the vertical drum.

The machine is made by Hk. Jonker en Zoon, V. N. Fabriek Amsterdam.

It would be suitable for dealing with large quantities, and produces a very fine and silky kapok.

Finally, it is recommended that a system of ginning be adopted which does not unduly break the floss. In the above account one hand arrangement has been shown to be suitable in this respect. The Bley Machine of all the machines discussed strikes one as the most reliable, having stood the test of long practical usage, and being inexpensive.

In connection with quality of floss the following standards have been decided upon by the "Handelsvereeniging" (Commerce Association), Samarang for kapok.

First Grade.—Known as "Superior Java" Containing less than .5% seed.

Second Grade.—Known as "Prime Japara" Containing not more than 2% of seed.

Third Grade.—Known as "Fair Average Java kapok" not more than 3½% of seed.

Buyers must accept delivery if seed content is not more than 1½% for "Superior Java", 5% for "Prime Japara" and 6% for "fair Average Java kapok."

It is stated that the quality demanded by America is that between the second and third grade, and by Australia, third grade or lower. From various enquiries it seems that Australia does not demand this poor quality but really requires good quality kapok.

PRESSING AND BALING.

In baling kapok for export it must be borne in mind that, on the one hand, excessive pressure will destroy the elasticity and quality of the fibre, while on the other hand, too small a pressure will result in heavy freight charges,—which are calculated on the volume of the rectangular bale. The exporters require that the pressure should be such that 2-2½ pikuls of floss would be contained in a bale of 36 cubic feet. Such a bale would require a pressure of about 140-150 lbs. per square inch, so that a bale of 3 feet × 3 feet (the height of the bale has no effect on the pressure required) would require a total pressure 181,440 lbs. (36 × 36 × 140); a bale of 2 feet × 2 feet a pressure of 80,640 lbs. (24 × 24 × 140). It is clear that a small bale requires a much less powerful press than does a large bale. Machine-cleaned or very dry fibre requires rather more pressure than does hand-cleaned floss. The following Report(1) indicates the material damage that may in occasioned by the over pressing of the bales.

"At the end of 1920, the Association of the Capoc Trade in "Amsterdam called the attention of the trade here to the fact that the "bales of capoc were being pressed to such an extent that the finest "quality suffered from it.

"The heavy pressure, a direct result of the high freight rates, "is done at the request of buyers, and exporters should therefore not "be held responsible for it."

Bley mentions the following dimensions of bale as satisfactory 28 inches × 26 inches × 24 inches, in height, weighing 90-100 lb., and points out that the bale should not be too heavy to be handled conveniently by one man.

Bales as received on the English market are pressed in sacking and bound with some sort of fibre. The bales are 2 ft. × 2 ft. × 5 ft 6 inches, weighing about 1¾ cwt.

Enquiry in Java on this question produced the following information:—"Kapok exported is hand pressed in bales packed in gunny "bags and bound with iron hoops; for European shipment in bales "weighing 1.60 pikuls (or 217 lbs); for Australian Shipment in "bales weighing 1.20 pikuls per double bale, and 0.80 pikuls per "single bale."

Henrie Jumelle in "Cultures Colonials-Planter-Textiles" says that kapok is baled in jute sacking for export to Australia, and in matting for Holland.

Information from Java is to the effect that hydraulic baling is necessary for export, while for inland convenience the kapok is pressed with the aid of handscrew presses made for kapok baling by several manufacturers in that country.

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(1) Report on Commence, Industry and Agriculture in the Netherlands East Indies during 1920.

Bley describes the following types of press.

1. Bley Screw-press:—This consists of a four-sided chamber, extending from floor to ceiling, fitted with two screws, one above and below. The upper screw is worked by hand by coolies in the room above, the lower from a cellar or lower room. The final turns of the screw are given by means of a long lever.

2. Experienced coolies can turn out 30 bales in 12 hours.

2. Side-screw presses—These have two screws outside the press and can be driven either by hand or machinery; they are supplied by various English makers.

Messrs. Hollings and Guest, Ltd., Engineers, Thimble Mill Lane, Birmingham, are the makers of presses suitable for baling kapok. They state that they have sent out to Java numbers of presses for this purpose. After referring to the type usually supplied they state: "Any of the standard sizes are suitable, depending upon "the size and weight of bale required, though we may say that the "size generally supplied is the No. 1, with Box 2'0" × 3'0" × 6'0" in "depth." The price of this particular machine is marked at £250.

Hydraulic presses are the best for kapok if properly constructed. The pump must be driven by power; motor, petrol-engine, steam or water power. If power is not available, a screw-press should be used.

The pump should have an automatic link-motion to give low power at first, changing to high. The press must have a long stroke, at least three times the height of the pressed bale.

Packing.—Bales are generally packed in jute gunny bags or in Borneo matting. For small bales, such as are recommended, 4½ yards of 28 inch gunny bagging is necessary.

Bands.—Rotan has been much used in the past, but it is unsuitable as it is too small and sharp, and cuts into the bale. Iron bands are much better, but should be galvanised or varnished to protect the bale from rust. Bamboo has been found very satisfactory: it is light, strong and, of course, free from rust. Probably fibre bands are the most suitable.

Markets.

(a) *Local Markets.*

The main sources of supply for the local markets are Java and Sumatra. Locally grown kapok is rarely procurable except in small quantities. At the present time kapok from Java sells retail for from \$50 to \$60 per picul, while that from Sumatra is worth about \$35--\$40 per picul. The former supplies come from Samarang, Java, and are known as "Prime Samarang," while the latter is from Tapa Toen, Sumatra. About 500 piculs per annum are consumed by the local European shops, but this is but a small proportion of the total local consumption of imported kapok.

(b) *Export.*

At the present time Java produces 80% of the world's consumption of kapok. In this connection it is interesting to note that advice from Java states:—"Yet the industry there (in Java) is in a "very primitive stage and undeveloped." The statistics for 1920 shew the following kapok shipments from Java

Into United States of America	...	5,545 tons.
Into Australia ...	...	3,415 „
Into Holland and the rest of Europe	...	2,528 „

The imports of kapok into the United States have been as follows:—

1913	2,842	tons,	value.	$ 809,001 gold.
1918	9,576	„	„	2,820,474 „
1919	10,972	„	„	3,673,285 „
1920	9,881	„	„	3,847,610 „
1921	8,165	„	„	2,556,699 „

Many other countries export kapok in small quantities, the principal of which are the Philippine Islands, Ceylon, India and some of the countries of South America.

The kapok market is inviting increasing attention at present. The Times Trade Supplement of July 29th, 1922 under the title of "Ceylon Kapok Boom" stated:—"The demand for kapok has of late "become very strong. The first shipment of any considerable bulk "was forwarded from Colombo in April. At that time there was only "one shipper at Colombo, and he paid up to Rs. 50 per cwt. for "cleaned kapok of good quality. At the end of June there was a dozen "Colombo shippers ready to buy at Rs. 65 per cwt for fair quality "but sellers are holding out for Rs. 70. It is said that middleman "speculators are now booking forward crops at as much as Rs. 80 "per cwt."

Importers of Kapok into England, America and Australia have written to the Department of Agriculture, Federated Malay States and Straits Settlements and particulars of buyers' terms and requirements will be sent on application. In this connection the following general conditions of shipping are of value to intending shippers.

(America) Shippers guarantee that loss in weight from shipping to landed weights will not exceed 1%. If it does, the excess is to be debited back to shipper. Arbitration as to quality to be held in New York. Quality is principally decided on odour, excess of seed and length of staple. Price to be in Sterling per lb. c.i.f. New York. For this market standard of clean kapok is that containing not more than 4% of seed.

It cannot be too strongly urged that kapok destined for export is to be of good quality and free from seed. The produce from Malaya is unknown on the world's market, and if early consignments are of good quality advantage may be taken of the good prices ruling at the present time to introduce Malayan Kapok as equal to Prime Samarang grade.

The present month October 1922 wholesale prices of kapok are about one shilling to 1s./1d. for Prime Samarang to four pence per lb. for the very indifferent and mixed kapok exported from India.

Australia in 1919/20 imported 5,828,750 lbs. of kapok to the value of £319,542.

Sydney	...	25,000 bales (160 lbs. in a bale).			
Melbourn	...	1,800	,,	,,	,,
W. Australia	...	300	,,	,,	,,
S. Australia	...	300	,,	,,	,,

Yield.

For the purposes of estimates, based on observations made in this country, and from the experience of cultivators in Java and the Philippines, it may be accepted that the yield per tree of pods in a mature plantation is 100 pods. This is undoubtedly a safe estimate. One hundred pods produce 1 lb. of clean floss.

Mathieu's figures of actual weight of twenty pods taken from a heap at Kuala Kangsar in Perak are as follows.—husks 8 oz., floss 8 oz., placentas and peduncles 1.25 oz.; total 18 oz.

The following figures obtained from various local sources indicate the variations possible :—

	T. Anson.	B. Gajah.	K. Kangsar.
Husks and Placentas ...	44	41	51
Floss	21	17.5	17
Seed	35	41.5	32

There are therefore about two pikuls of seed to one pikul of clean kapok.

Given 120 trees per acre the yield of floss would be about 400 to 500 lbs., and of seed 800-1000 lbs.

APPENDIX I.

THE ORGANIZATION OF THE KAPOK INDUSTRY.

The attention of the Department of Agriculture has been directed for some time towards the possibilities of organizing the local industry in Kapok, and it is proposed in this place to indicate the results of this investigation.

A rough census of kapok trees has been taken, with the results stated below;—

State.		No. trees.	Remarks.
Selangor	...	7,557	4,164 of which are in Kuala Selangor.
Negri Sembilan	...	3,887	Scattered.
Pahang about	...	5,000	,,
Perak	...	61,925	40,000 of which are near Perak River. 20,000 in Krian.
Malacca	...	7,000	Scattered.
Penang	...	6,100	4,000 of which are in Balik Pulau

or say 100,000 trees.

Thus if organization was perfect, the trees at present in existance are capable of producing annually at least 100 tons of clean floss, worth about $1000 per ton and 200 tons of seed.

Of the trees at present in bearing nearly three quarters are to be found in definite workable areas: viz., Perak River, Krian, Balik Pulau and Kuala Selangor. It is then, in these districts that endeavours will be made to educate the Malays to harvest their crops, and prepare the floss for market. Collecting centres will be established at which cash will be given for the kapok as brought in. In the past, the price given by Chinese buyers was so small as to offer no encouragement to the Malays to harvest their crops, except for their personal use, or to reduce the amount of their debts to the local Chinese shop-keeper.

It is not the intention of the Government to become traders in kapok. The organization of the industry will depend on the enterprize of unofficials; but the Government will assist by using their influence with the Malays to induce them to harvest, and to use the correct method.

In the districts containing a large number of trees, arrangements have already been made for the purchase and preparation of kapok under European management.

Finally, the question will be asked: "Will it pay to plant kapok on a large scale?" The answer to this question depends on the conditions of planting. It is of course impossible to forsee the condition of the market in four years time, but from present indications it seems that there is considerable scope for a larger area to be cultivated with this crop. The opinion of this Department is that kapok will undoubtedly pay when cultivated on mixed plantations, as the cost of production is low. Mathieu has estimated that the cost of harvesting and cleaning would not be more than 12 cents per lb; and freight etc., to London 2.5 cents per lb. or say 14.5 cents per lb. from harvesting to London. The land being utilized for other crops in addition to kapok, the cost of cultivation can be divided between the crops occupying the ground.

APPENDIX 2.

Importers of Kapok.

England.

H. J. Lederer, 23/24 Farm Street, London, E.C.I.
A. Wallis, 10-11 Lawrence Lane, London. E.C.

America.

F. R. Henderson & Co., Inc. New York.
The Robinson-Roders Co., Inc. Sourabaya, Java.
H. E. Smith, 112 Market Street, San Francisco, Calif.

Nen South Wales.

R. A. Andrews, Davis and Raper Streets, Surrey Hills.
Bateman, Sydney.
E. W. Beard & Co.. 49 Paramatta Road, Gelebe.

New South Wales—*contd.*

E. Bentley & Sons, Fitzory Street, Marrickville (Importers of Cordage).
Bowan Bros. & Co., Ltd , Sydney.
Bruton & Wheeler, 307 Sussex Street, Sydney.
J. H. Buttler & Co., Ltd., Sydney.
A. Forsyth & Co., Ltd., 339 Kent Street, Sydney (Importers of Cordage).
Goodearls Ltd., 406 Kent Street, Sydney.
Grimley Ltd., Sydney.
Hooker, Chapman & Co., 188 Sussex Street, Sydney.
Nettleton Son & Co., 587 Kent Street, Sydney.
Pacific Commercial Co., Sydney.
A. H. Philips & Co., Sydney.
H. H. Sanders, Grafton.
Suzuki & Co., (Masuda Trading Co., Ltd.), Sydney.
S. Walder Ltd., Sydney.
C. E. Waters & Co., Ltd.. Sydney.

Queensland.

C. B. Barstow & Co., Charlotte Street, Brisbane.
Brabant & Co., Charlotte Street Brisbane.
Burns Philp & Co., Ltd., May Street, Brisbane.
Carricks Ltd., Saul Street, Brisbane.
Forsyth & Co., Ltd., Lytton Road, East Brisbane (Fibres).
J. W. H. Grant Ltd., Queen Street, Brisbane.
Gunnerson, Crockett Ltd., (Queensland) Bowen Street, Brisbane
King & King. Ltd., Queen Street, Brisbane.
Koonoomoa Co., Merivale Street, South, Brisbane.
Laycook, Littledike & Co., Ltd., Herschell Street, Brisbane.
McWhisters Ltd., Valley Street, Brisbane.
Rosenstengels, Ltd., Ruthven Street, Toowoomba.
Shamblers Ltd., Gympie.
C. H. Slate & Co., Eagle Street, Brisbane.
Leonard Spencer, Brisbane.
Stuparts Ltd., Keat Street, Maryborough.
Geo. Wills & Co., Ltd., Wharf Street, Brisbane.

South Australia.

J. W. Gresby & Co., Adeladie.
Prevost, Selth & Co., Adelaide.

Victoria.

Alfred Harvey & Co., Melbourne.
Branchaw & Allen, Melbourne.
Collins & Co., Pty. Ltd., Melbourne.
T. W. Cotton Pty. Ltd., Melbourne.
Eastern Imports Pty. Ltd.. Melbourne.
Geo. P. Harris, Scarfe & Co., Ltd., Melbourne.
The Mutual Store Ltd., Melbourne.
Prithard Bros, Readings.
A. Victor Legge & Co., Melbourne.

Western Australia.

Boan Bros., Perth.
McCorkill & Co., Perth.
Foy & Gibson, Perth.
C. & H. Locke, Fremantle.
Bon Marche, Perth.
A. Povey, Wellington Street, Perth.
Brown & Dureau Ltd., Wellington.
Cardale & Scott, P. O. Box 985, Wellington.
A. Clarke & Sons, 41 Elliott Street, Auckland.
Joseph Clarke & Co., Wellington.
Clarke & Co., Pty. Ltd., Wellington.
Dalgety & Co., Ltd., Featherstone St. Wellington.
Direct Importing Coy., of N. 2. Ltd., Panama Street, Wellington.
Ellison & Duncan Ltd., Napier.
Harrisons Ramsey Pty. Ltd. P.O. Box 1533, Wellington.
Henry Olsen & Co. Pty. Ltd., Wellington.
B. L. Hart & Co., Ltd., 92 Tory Street, Wellington.
Archur E. Kewin & Co., Wellington.
Kirkcaldie & Strains Ltd., Wellington.
Macky, Logan, Cardwell Ltd., Elliott Street, Auckland.
David McCrae Ltd., Wellington.
Sargood Son & Ewen Ltd., 96 High Street, Dwindin.
Speedings Ltd., P.O. Box 462, Fort Street, Auckland.

APPENDIX 3.

COSTS AND INCOME OF 500 ACRES OF KAPOK, (1911).

The following figures are based on those given by McGillvray in "Kapok; Rentabiliteit" published in 1911, by the Nederlandsch-Indisch Landbouro Syndicaat, for the cultivation of kapok only in Java. The price of the clean floss has since risen from \$18.50 per pikul to about \$50 per pikul, while the cost of production has also increased, but certainly not to a proportional extent.

EXPENSES.	\$	\$	INCOME.	\$	\$
Preparation.					
1st 250 acres, clearing roads, Quitrent, wages etc.		7770			
1st Year.					
Planting 250 acres and cleaning round trees.	370				
Preparing 2nd 250 acres.	2440				
Quitrent, wages and various.	4250	7060			
2nd Year.					
Upkeep 250 acres and green measuring.	530				
Planting 2nd 250 acres.	370				
Quitrent and wages.	4040	4940			
3rd Year.			*3rd Year.*		
Upkeep 500 acres.	1060		Kapok from 250 acres at \$18.50 per pikul less \$3.70 harvesting, preparation and transport:—\$14.30 per pikul.	1427	
Quitrent and wages	3870				
Factory ane various	3900	8830			
			Seed at \$1.48 per pikul.	318	1745
4th Year.			*4th Year.*		
Upkeep, wages factory and bags.		8830	Kapok from 1st and 2nd planting.	5240	
			Seed „ „	1165	6405
5th Year.			*5th Year.*		
Upkeep, wages etc.		6360	Kapok ...	9525	
			Seed ...	2119	11644
6th Year.			*6th Year.*		
Upkeep, wages etc.		6360	Kapok and Seed.		13979
Total ...		50157	Total ...		33773

It is evident from the above that where other crops are grown in conjunction with kapok, the plantation reaches a paying stage at a much earlier date.

THE

Malayan Agricultural Journal.

Vol. XI. February, 1923. No. 2.

EDITORIAL.

RUBBER CULTURE IN THE PHILIPPINES.

Since the introduction of restriction, the newspapers have contained statements emanating from the U.S.A. to the effect that rubber growing would be taken up on a large scale in the Philippines presumably to make America independent of supplies from Malaya and Ceylon.

Attention has been given in the Philippine Islands to rubber for some years past, apparently without conspicuous success, and the following extracts from an article in "The Philippine Agriculturalist and Forester" of September 1916 Vol. V, No. 5, page 159 on "Local Growth of Rubber and Gutta percha Plants," by R. O. Sarmiento do not suggest that the American threat will readily materialise.

"A number of plantations have been started in the Philippines, and on other plantations, rubber has been planted incidentally in association with other crops regarded as staples. As a rubber plantation, the only successful one up to this time is that established and managed by Dr. Strong, near Isabela de Basilan. At this place, Mexican and Ceara rubber have been tried and discarded; Para rubber has been successful and is now paying the cost of the plantation, including a rather rapid extension of area. On the plantation of Mr. Orville Wood on the Gulf of Davao, Mexican and Para rubbers were planted, and Mexican rubber proved the more successful under the local economic conditions."..... .

"At the College of Agriculture, as complete a collection of rubber producing plants as possible was assembled several years ago. Experience with these various plants has brought College authority to the conclusion that conditions of temperature and rainfall at low altitudes in all parts of the Islands are suitable for some rubber-producing plant or other; but that rubber-producing plants as a whole are so susceptible to damage by storms that the establishment of rubber plantations is not a safe business undertaking except in the extreme southern part of the Archipelago. In the far south, in the

"belt of tropical calms," where typhoons are practically unknown, Para rubber can be expected to succeed, where wet and dry seasons are not too distinct, and the Mexican rubber to succeed where the dry season is severe. The more recently discovered species of Manihot, and some of the rubber-producing vines, have still to be given careful test; the vines, but not the Manihot, may be cultivated where typhoons occur, if they prove able to produce rubber at a satisfactory profit." (*January 2nd, 1923.*)

THE PRACTICE OF BUD-GRAFTING.

Results obtained in Java by tapping 4-5 year old bud-grafts (Malayan Agricultural Journal Vol. X. No. 7, page 174) have shown that it is no longer possible to assume that bud-grafts from high yielders will all be high yielders. While all the grafts from one mother-tree resemble one another in yield more closely than a random assortment of seed plants this yield may be high, medium or low, independently of any ascertainable character of their mother-trees.

It is obvious that the best results can only be obtained if "good" mother-trees are used; at present, there is no method of ascertaining whether any mother-tree is "good" other than the direct and lengthy one of growing and tapping a number of offspring from it. Bark characters, *e.g.* numbers of latex rings have not so far been proved to be reliable either in the mother-trees as measures of "goodness" or in the young grafts as a guide to probable yield.

It was pointed out in the article cited above that bud-grafting has not yet passed the experimental stage and been established as a commercial success. Should however any Estate or group of Estates contemplate planting areas of any size with bud-grafts in the future, it is strongly recommended that experimental plots of about 60 grafts—say 1 acre—per mother-tree should be laid down, and the trees tapped from their 4th year.

Needless to say, the marking and identification of parent trees and grafts must be carried out as carefully as in any other scientific experiment.

As far as possible the Department of Agriculture will be prepared to help with advice those who contemplate experimental work as outlined above.

It must clearly be understood that the laying down of such plots is not advocated as a guarantee of success; it may however ensure the saving of considerable sums. (*January 2nd, 1923.*)

PRELIMINARY REPORT ON BROWN BAST EXPERIMENTS IN MALAYA.

BY A. SHARPLES AND L. LAMBOURNE.

A previous review (7) by the senior author treats of the early work carried out in Malaya to find a causal agent for Brown Bast. Some attention is devoted to the published work of various authors, more especially to that of Rands (5) whose work in Java was contemporary with and parelleled that carried out in Malaya. The recent work of Sanderson and Sutcliffe (6), Bryce (2), Bateson (1) and Farmer and Horne (3) was briefly considered . the latest work to appear is a detailed treatise by Keuchenius (4) working in Sumatra.

Experimental work on Brown Bast was taken up by the writers in 1919. At this time the physiological nature of the disease was recognised by most authorities working on the subject and the evidence in favour was overwhelming. More light upon the problem could be obtained only by working upon the individual factors influencing the incidence and development of the disease. This was obviously a matter for field experiments.

The way was opened up by Rands' (loc. cit) heavy tapping experiments which showed that a high percentage of trees developed Brown Bast when tapped six times a day on three superimposed quarter cuts. Belgrave adapted the heavy tapping to Malayan needs by substituting a full spiral cut, once daily, as sufficient to produce an appreciable percentage of Brown Bast in a few months time. The experiments comparing Daily, Alternate Daily and Every Third Daily on ¼ Spiral, ½ Spiral and Full Spiral cuts published in the review mentioned above were in hand when the senior writer took over.

In this first series of experiments the number of Brown Bast trees was verified by Mr. F. W. South, Chief Agricultural Inspector, F.M.S. and S.S. while the yield figures were later worked out and analysed by the writers. This analysis presented many interesting features and further field experiments were planned to test as many points as could be conveniently dealt with.

This article will deal briefly with the more important points observed, full details being reserved for a final publication. The first series of experiments indicated :—

(1) That comparative Brown Bast experiments could not be conveniently dealt with using the tapping systems commonly in vogue. A single daily cut on a quarter or half of the tree does not give an amount of Brown Bast sufficiently large to lead to any definite conclusions. Therefore drastic tapping systems have to be resorted to.

(2) Comparative results on Full Spiral tapping with different intervals, *i.e.* Daily, Alternate Daily and Every Third Day, showed a large percentage of Brown Bast trees in the Daily plots, a greatly reduced number in the Alternate Daily and a still further reduction in the Every Third Day plot. The Alternate Daily plots had about 400 trees each, the rest approximately 550 trees. The Brown Bast figures after seven months were

Daily.	Alt. Daily.	Every Third Day.
102	42	24
20%	10%	5%

The differences are sufficiently large to warrant the statement that "On the same length of cut, Alternate Daily tapping is superior to Daily tapping from the point of view of Brown Bast, while a further improvement can be effected by extending the intervals between tappings."

(3) The yield figures are suggestive. For example total yields from the Daily ½ Spiral plot = 1019.94 lbs., from the Alternate Daily ½ Spiral = 523.14 lbs., and Every Third Day ½ Spiral = 383.67 lbs. A rough comparison can be made by taking the Daily ½ Spiral yield as standard and then multiplying the yield figures of the other two plots by two and three respectively. This gives

Daily ½ Spiral.	Alt. Daily ½ Spiral	Every Third Day ½ Spiral.
1019.94	523.14 × 2 = 1046.28	383.67 × 3 = 1151.01

These figures, taken over seven months, fall within expectations and the yield figures of the Alternate Daily ½ cut and Every Third Day ½ cut are of a similar nature with reference to the Daily ½ cut. With the Full Spiral system the final comparative figures show large differences as follows :-

Daily F.S.	Alt. Daily F.S.	Every Third Day F.S.
	2122.78 × 2	1832.91 × 3
2802.25	~~2802~~.25 × 2 = 4245.56	1832.25 × 3 = 5498.76

These figures if supported by further evidence are very significant. They indicate the lack of exact knowledge regarding the response made by *Hevea brasiliensis* when tapping systems outside the ordinary routine are in operation. This point is of considerable importance in relation to the Brown Bast problem, for many investigators are in accord in regarding this affection as a wound response due to over-tapping. If high-yielding is a factor of importance, the results also indicate the possibility of yields being limited by the development of a high percentage of Brown Bast. In the writers opinion it appears probable that according to type of soil and general growth conditions in any area the yield is sharply limited. Below this limit the amount of Brown Bast developed is of little importance from a practical standpoint but above the limit there is a tremendous percentage increase disproportionate with the increased yield. This point must be taken into consideration in the general question of obtaining high-yielding strains of *Hevea Brasiliensis* by bud-grafting and selection. The Brown Bast problem, in fact, apart from its scientific interest, is of little general importance during a period when

ERRATUM.

Vol. XI, No. 2, page 31, line 30—*should read.*

2802.25 $\quad$ $2122.78 \times 2 = 4245.56$ $\quad$ $1832.91 \times 3 = 5498.76.$

restricted yields obtained by increasing the length of time between tappings *i.e.* Daily to Alternate Daily, are the rule. The Brown Bast problem becomes of primary importance when considered as a limiting factor in the question of high yields.

The above first series of experiments indicated other points of interest. A sudden jump in number of Brown Bast cases during certain months had to be confirmed or otherwise; in view of this peculiarity it appears that to obtain a guiding line as to the behaviour of different plots with reference to Brown Bast development at least three months previous heavy tapping is necessary. These points were confirmed by many later experiments so that subsequently the experimental plots were subjected to three months preliminary tapping on a Full Spiral, once daily.

In the second series of experiments 410 trees were taken and after the three months preliminary tapping were divided into blocks of approximately 50 trees. The small plots were then put under systems with varying lengths of cut from ½ Spiral to Full Spiral. These trees were 12 years old; The trees were opened up for tapping during the fourth year at 24 inches from the ground on a single V and in order to obtain time for bark renewal the second period was carried from the 36 inches to the 24 inches mark when the opposite V panel had been tapped. To get tappable bark of the same age our experimental tapping had to be carried out in virgin bark over the 36 inches mark. The more important results are mentioned below.

(1) The sudden rise followed by a long rest period indicated previously was confirmed by these and all later experiments. The 1921 experiments supported the experience gained in 1919 in that the months, March to August were quiescent Brown Bast months. This suggested the possibility of wintering and low rainfall both influencing the results. However, 1922 showed May, June and July as heavy Brown Bast months and these are usual months of low rainfall which are fairly constant, year by year, in this district. As far as observations have been carried there is some difficulty in associating any external factors with the results obtained.

(2) Another notable feature in this series of experiments was the stoppage of the extension of Brown Bast at definite places marked by the different ages of tapped bark. As indicated above, the vertical sequence from above downwards was in virgin bark—this passed into renewed bark two years old at the 36 inches level and this panel passed into 4—6 years old renewed bark at the 24 inches mark. To record briefly—out of 410 trees, 133 developed Brown Bast. Of these, no extension took place after tapping was stopped in 10 trees. In another 20 trees the Brown Bast stopped at the 36 inches mark, (the junction between the virgin and the youngest renewed bark); in 47 trees the Brown Bast extended to the 24 inches mark (the junction between the old and young renewed bark), and in 19 trees the affection extended to the base of the tree.

These results are of both practical and theoretical importance and have been confirmed by subsequent experiment. Details must be left to a final paper.

(8) Special importance is assigned to a plot of 14 trees, tapped on a ⅞ Spiral, the heaviest system apart from the Full Spiral. While the neighboring seven plots were responding to experiment in a normal manner this plot was obviously abnormal. From November, 1920 to August, 1921 only two Brown Bast trees were reported. In September, 1921 a sudden increase of six Brown Bast trees was reported.

The abnormally long quiescent period might have considerable significance and tapping on this plot was continued. A control plot was obtained by continuing the tapping on one of the normal plots which had been tapped on a ¾ Spiral.

From September, 1921 to December, 1922 the abnormal plot developed Brown Bast in a normal manner. The change was correlated with a sudden increase in average tree yield. This correlation is supported by figures taken over a considerable period of time, the curves for average tree yield and percentage increase in Brown Bast cases conform closely to one another. The conclusion must be drawn that Brown Bast is closely associated with the question of high yields and it is almost certain that this affection must act as a limiting factor in the question of high-yielding trees.

The appearance of a number of Brown Bast cases is so sudden that it may be classed under the phenomena dependent on "trigger action," *i.e.* a sudden release followed by immediate effects. In the space of 24 hours the typical Brown Bast symptoms as known from field observations, will become obvious on numerous trees which had shown none the previous day. A most important question to be answered is "What changes take place in the physiological processes leading up to this sudden release?" It appears most probable that the Brown Bast affection is to be considered as an exhaustion process. Accepting this point of view, it has been possible to connect up many isolated observations; further, laboratory observations previously contradictory, fall into line when this basis is utilised.

Tapping experiments have been carried out to test other points of interest, such as specific immunity, permanancy of yield in good and bad yielders and their behaviour towards Brown Bast development, etc. Details of these must be left for a final article.

Another line has been taken in hand recently owing to Farmer and Horne's researches on specimens sent from the Middle East to England for examination. These investigators describe a breaking-down of the sieve-tubes and suggest this as an incipient stage in Brown Bast. This type of abnormal behaviour is included under the term of Phloem Necrosis, typified in other cases by lignification of the cellulose walls of the sieve-tubes. Lignification of the sieve-tube walls is a common feature in the tapped bark of *Hevea brasiliensis*, moreover in trees which could not be suspected of Brown Bast. The findings of Farmer and Horne have been given some prominence in an article in Nature by Dr. S. E. Chandler but the senior writer, having had this particular phase of sieve-tube changes under observation for the last three years would accept their suggestions with

considerable reserve. Plots of trees, with and without lignified sieve-tubes have now been selected and similar tapping experiments to those described will be carried out to determine which develop Brown Bast most quickly. The results, up-to-date, show that trees originally non-lignified become lignified after being tapped for some time.

The line taken throughout this investigation has been with reference to the disease factor influencing future policy on Malayan plantations. Big claims have recently been made, with reference to increased yields per acre, for trees developed by bud-grafting from known high yielding trees. A forward policy is certainly desirable but the attendant risks should be fully realised.

Apart from the considerable body of evidence obtained during the present investigation which, at least, cannot be said to favour the policy urged by the supporters of bud-grafting, the general position at the present time is seldom clearly presented. If excessive yielding results in exhaustion, then high-yielders will tend to show this effect sooner than average yielders. Further, this feature must be closely connected with some difference in physiological activity and the higher the yields the greater this difference becomes. Plant morphology is now recognised as an expression of physiological activity and small changes in the latter may produce far-reaching effects in plant structure. In the case of *Hevea brasiliensis* in Malayan plantations, an insufficient development of leaf cuticle would give many organisms a chance of effecting an entry and invading the leaf tissues. Positive evidence to this effect has already been obtained in Malaya. On one estate where bud grafts were successfully established on three year old stocks, the leaves of the graft were badly attacked by several species of fungi usually saprophytic. This resulted owing to the leaves being too abundantly supplied with nutrient material from a root system which previously had supplied many thousands times the number of leaves. The leaves of these bud-grafted plants were pale-colored, thin and obviously deficient in cuticle when compared with the usual type of rubber leaf.

Should the optimistic yields from bud-grafts materialise, the trees certainly will have physiological activities of a different order to those obtaining in the present day plantations. The direction will be towards accelerated vital activities, *i.e.* transpiration, respiration and absorbtion. Strong cuticular development is not usually associated with active transpiration, and it is possible that high-yielding bud-grafts may tend to develop less resistant cuticle.

At the present time there is a very dangerous organism epiphytic on rubber leaves which with little encouragement, would be able to cause much damage if it could penetrate into the leaf tissues, and it is doubtful if much could be done to check its activities. This parasitic alga has been long known as the cause of serious losses on Tea and Cloves; recently the senior writer visited Sarawak to investigate a disease of Pepper Vines which had been responsible for a reduction of exports from $2,783,301 in 1903 to $712,122 in 1920. The cause of this disease was the same parasitic alga, *Cephaleuros mycoidea* (Karsten). Again, rubber planting in British and Dutch

Guiana has been rendered unprofitable by the attacks of a leaf fungus and it is more than possible that this organism may have a close relation in the Middle East capable of doing damage under favourable conditions.

The point to be clearly recognised is that the margin of safety is small and that exceedingly large risks are attached. It is for these reasons that we claim that the published bud-grafting results are insufficient upon which to base any definite policy, that neglect of vital factors in the published results calls for strong comment from a scientific point of view and that no great care has ever been taken to point out the attendant risks. The admission that in Malaya there has been no opportunity to carry out experimental bud-grafting for ourselves, does not prevent us calling attention to the shortcomings in the records presented by the published results relating to bud-grafting.

(1) Bateson, E. ... The Tapping of the Para Rubber Tree Bull. No. 23, Department of Agriculture, F.M.S.

(2) Bryce, G. ... Bull. No. 28, Department of Agriculture, Ceylon, October 1916.

(3) Farmer, J. B. and Horne, A. S. Phloem Necrosis, Brown Bast disease in Hevea brasiliensis. Anns of Botany, Vol. XXXV, No. CXXXIX, July 1921.

(4) Keuchenius, P. E. ... Die Rindenbraune der Hevea Brasiliensis. Cent. for Bacteriologie, Parasitenkunde und Infektionskrankheiten Zweite Abteilung, Bd. 55/1921 Heft 1/4.

(5) Rands, R. P. ... De Bruine Binnenbastziekte Van Hevea Brasiliensis: Archief Von Rubber Cultuur in Ned. Indies 1919.

(6) Sanderson, A. P. and Sutcliffe, H. Brown Bast. Rubber Growers Association, 38, Eastcheap, London, E.C. 3.

(7) Sharples, A. ... A consideration of recent work on the Brown Bast problem, Malayan Agricultural Journal, June 1922, Vol. X, No. 6.

Received for publication 28th February, 1923.

FINAL REPORT ON TREATMENT OF MOULDY ROT DISEASE WITH AGRISOL.

BY A. SHARPLES.

TWO previous reports dealing with the above have been published in the Agricultural Bulletin F.M.S. The first (Vol. IX, 1921, No. 3) dealt at length with the purely experimental side, the second (Vol. IX, 1921, No 4) with details of comparative costs over a 5 months period under estate conditions. The results and figures as presented were decidedly encouraging, and if maintained over a lengthy period, indicated efficient control at a remarkably low cost.

This treatment on the estate in question has now been carried on over a period of eighteen months and has proved satisfactory though the Manager raises an objection that the treatment does not eradicate the disease. This point might now be dealt with in order to clear up misconceptions.

The writer's opinion is that *complete eradication is impossible*. The utmost that can be attempted is control *i.e.*, preventing spread and increase in number of diseased trees on individual estates. In the life history of the fungus causing Mouldy Rot, there is a stage when resting spores, *i.e.*, dark colored, thick walled macrospores, are produced abundantly. These spores can withstand adverse conditions, lying dormant during lengthy drought periods and are capable of germinating when wet weather arrives. The production of these resting spores marks the greatest difference, from a practical point of view, between the *Phytopthora* sp. causing "Black Stripe" disease on the tapping surface and *Sphaeronema fimbriatum* the fungus causing Mouldy Rot. A spell of dry weather will cause the complete disappearance of the "Black Stripe" disease because the fungus does not produce spores resistant to dessication. This point is of some importance in the question of Mouldy Rot control for if properly appreciated there is little danger of a careless attitude with the resulting neglect of proper precautions. There is little doubt that an estate, once attacked by Mouldy Rot, will have a recurrence of the disease and the damage done will be inversely proportional to the care taken to prevent a new outbreak spreading.

The cost of controlling the disease with Agrisol over a period of 18 months, on an European estate, worked out at 10½ cents per acre per month. (For particulars of working see the two articles mentioned above). The Manager reports that the treatment insures the bark against injury There is always a number of Mouldy Rot cases to be treated at any one time, but this number does not increase from month to month, and as the bark is kept in good condition, the only factor to be taken into account is that of cost. This figure is remarkably low.

This preventive work on Mouldy Rot gives good reason for stating that this disease can be effectively controlled, and need not be

considered as a vital factor in the economy of any European estate. The position, with regard to native holdings, is somewhat different owing to the difficulty of making native owners realise what care is necessary, and more especially the necessity for a careful watch to be kept for a recurrence of the disease after apparently successful treatment. Difficulties of distribution, errors owing to careless painting, etc., etc., also enter into the problem. However, from that point of view of the individual estate, surrounded by affected holdings, the disease can be effectively controlled as in the case on the estate where the experiments were carried out. Naturally more care is required under such conditions, and costs increased to some extent, but in all disease control in tropical countries, the presence of large numbers of native holdings increased the difficulties. However, work in the direction of educating native owners is being steadily carried on by the Inspection staff of the Department and this, no doubt, will result in much improvement.

Received for publication 29th January, 1923.

NOTE ON MINYAK NYATOH (OIL FROM PALAQUIUM SPECIES).

BY C. D. V. GEORGE.

AMONG the samples of Oils and Fats exhibited in the Agri-Horticultural Section of the Malaya-Borneo Exhibition was a sample of Minyak Nyatoh prepared by Syed Abdul Rahman, Junior Agricultural Assistant, Pekan.

As this fat had been prepared carefully and was obviously free from impurities it was decided to investigate the sample and ascertain its analytical constants.

Minyak Nyatoh is the local name of fat which is extracted from seeds of one of the species of the Palaquium genus (Natural Order Sapotaceae) all of which yield gutta-percha.

According to de Jong and Tromp de Haas (Chem. Rev. 1904.285) this particular fat is obtained from *Palaquium Oblongifolium* Burck; and the figures which are published by those investigators are in relatively close agreement with those obtained for the present sample as the following table shows:—

Fat.		Present sample.	de Jong and Tromp de Haas.
Melting Point (Capillary Tube)	...	42°C	40°C
Density 99°C (Water at 15.5°C = 1)	...	.8571	...
Refractive Index (40°C)	...	1.4570	...
Saponification Value	..	190.6	201.5
Iodine Value (Wijs method)	...	46.6	34.3
Acidity (Oleic Acid per cent)	...	1.1	2.1
Unsaponifiable per cent	...	0.4	
Fatty Acids.			
Solidifying Point (Titer Value)	...	55.5°C	...
Iodine Value	...	40.0	...

Minyak Nyatoh is a hard white fat with a pleasant smell and if available in sufficient quantity would certainly compete with Borneo Tallow, Illipe Fat and other similar fats. It could be used for edible purposes, as well as for soaps and other products for which those fats are employed.

Received for publication, 1st September, 1922.

NOTES ON KAPAYANG OIL.

By C. D. V. Georgi.

IN a previous number of the Agricultural Bulletin, Vol. II, 1913-1914, page 67 an account was given of the results of the examination of Kapayang seeds received from the Conservator of Forests.

During the past year two further samples of these seeds have been received and in view of the fact that, although the seeds are both known locally as Kapayang, they are derived from different plants it has been considered advisable to publish the results.

Results of Analysis.

The details of the examination of the seeds and of the oil are shown in the appended table, those for the previous sample being added for purposes of comparison.

Conclusions.

From these results it will be seen that the sample of Kapayang designated 'A' is doubtless derived from the same species as that previously examined, *Hodgsonia heteroclita*. As regards 'B', it is not considered that this can be the *Pangium edule* to which reference is made in Malayan Forest Records "Minor Forest Products of the Malay Peninsula," page 170, as the figure for the percentage of oil in the seed, 7.0 per cent., is not in agreement with that quoted, namely 50 per cent.

Further work is necessary therefore before deciding the name of the plant from which this second variety is derived.

Possibilities of Kapayang Oil.

Although the kernels of one of the varieties of Kapayang contain a large percentage of oil, Kapayang seeds have at present no economic value, the cultivation of the plants not as yet having been taken up commercially, they are purely a forest product.

There is one point which may be of interest, and to which attention would have to be given if the plants were cultivated, and that is the large number of seeds in both samples in which the kernel was undeveloped, which is probably due to non-fertilisation of the flower.

Until therefore the plant has been cultivated under field conditions no information can be given with regard to its commercial possibilities.

Received for publication 1st November, 1922.

Table Showing Results of Analysis of Kapayang Seeds.

Particulars	Previous sample.	Present samples. A	Present samples. B
Description of seed.	Hard flat outer shell, dull drab colour, average length 2½ inches, width 1 ⅞ inches. Containing soft oily kernel, with thin pericarp of dry mealy nature.	Hard flat outer shell ovoid in shape, buff colour, average length 3 inches, width 1¾ inches, thickness ⅛ inch. Containing soft oily kernel with thin pericarp of corky tissue.	Hard flat outer shell, ovoid in shape, buff colour, average length 1¾ inches, width 1¼ inches. Containing a firm moist kernel enclosed in a thin pericarp of corky tissue.
Average weight of seed.	36.0 grams.	38.0 grams.	..
Proportion of shell	55.3 per cent.	44.5 per cent	47.2 per cent.
Proportion of kernel.	44.7 per cent.	55.5 per cent.	52.8 „
Analysis of kernel.	Kernels contain 59.4 per cent of oil, corresponding to 26.2 per cent on whole seed. (Petroleum Ether extract.)	PER CENT. Moisture 12.3 Oil (Pet. Ether Extract) 57.4 Residue (by difference 30.3 Oil (On dry kernel) 65.4 Oil (On whole seed) 31.9	Kernels darkened on exposure to air and became mouldy so were partially dried off before analysis PER CENT. Moisture 10.6 Oil (Chloroform Extract) 21.9 Residue (by difference) 67.5 Oil (On dry kernel) 24.5 Oil (On whole seed) estimated 7.0
Description of oil	Light yellow. melting about 25° C.	Light yellow appears to solidify about 25° C but on standing for some time oil separates into two layers, the upper a light yellowish oil, the lower a white solid.	Very thick dark brown oil.
CONSTANTS OF OIL.			
Density	0.9164 (15° C.)	0.922 (20° C.)	...
Refractive Index.	1.464	1.4694 (20° C.)	...
Saponification Value.	198.9	203.9	199.5
Iodine value.	65.4	63.6	107.3
Acidity (as Oleic acid per cent.	..	2.8	..
FATTY ACIDS			
Means molecular weight.	..	272.7	...
Solidifying point (Titer value.)	..	40.8° C.	...
Iodine value.	..	61.9	...

BRAZIL NUTS.

HEAVY CROP IN 1922.

(Reprinted from "Raw Materials Review," January 1923, page 85).

We are indebted to Messrs. Landauer and Co. for the information in the following article.

THE Brazil nut crop on the Amazon in 1922 has been quite unprecedented, and has exceeded all expectations. It is in excess of the previous crop, which itself surpassed all previous records, by the notable quantity of almost 8,000 tons.

The total exports from Brazil during the year amounted to approximately 34,000 tons. Out of this 18 000 tons were shipped to America and about 15,000 tons to England, whereas with other heavy crops the maximum quantity imported into England in any one year has never before exceeded 9,000 tons.

Prices have been very much below the level of recent years, and this has encouraged the public to show increased interest, with the result that Brazils to-day are one of the cheapest classes of nuts on the market. It is now obvious that if the nuts can be supplied at such prices as those ruling this year, this country can apparently consume almost fabulous quantities. This is due in part to the growing demand for Brazil nuts in the confectionery trade, on lines similar to that in America, where the nut is one of the principal ingredients in candy manufacture. It must also be remembered that the Brazil is looked upon as the King of Nuts, and should by rights command a premium over any other description.

It may interest our readers to learn how these nuts are handled prior to their arrival in this country.

The nuts are the fruit of the Bertholletia Excelsa, a huge tree which grows wild in the Amazonian forest, and reaches a height of about 100 feet. About fifteen to twenty-five of the angular nuts are contained in each of the thick-shelled pods. To break open these pods and remove the nuts would appear to the average person a most difficult task, but the natives, who collect them after they have fallen from the trees, open them comparatively easily with a few blows of a woodman's hatchet, such as is used on the Amazon for cutting one's way through the thick undergrowth in the jungle.

When the nuts have been thus extracted from the pods the usual method is to place, say, 20 lbs. of the nuts in a basket and dip them repeatedly into the river, when the bad nuts will float to the surface. This practice is termed the washing of nuts, hence the term "large washed nuts," generally applied to practically all the nuts from the source. The term "large washed" by no means indicates that such

parcels do not contain a percentage of medium-size or even small-size nuts, as it would be very unlikely that the pods from any one tree would contain only large-size nuts.

It might be thought that the inferior sizes should be picked out and sold separately, but this would be most difficult. Indeed, it would be almost impracticable for the up-river trader to select and grade the nuts as to size before shipping them down to Manaos and Para ; the labour would be costly, he would obtain a lower price for the inferior sizes, probably without commanding any higher price for the larger nuts ; and thirdly, there might be difficulties in trying to keep the different grades apart on the river steamers.

Although nuts similar to those of the State of Amazonas are found on certain tributaries of the river Amazon in the State of Para, the bulk are inferior in size to those of Amazonas. The same applies to nuts from the other adjoining States and countries, such as the State of Matto Grosso, Federal Acre District, or Bolivia.

In consequence of pressing recommendations by Manaos dealers, this washing process, now in almost universal use throughout the State of Amazonas, is also being largely adopted in the gathering of Brazil nuts in the State of Para, with the result that nuts should arrive in the latter centre in better condition than has been frequently the case in the past.

When sufficient nuts have been accumulated at stations in the interior, perhaps several hundred miles from the exporting centres of Manaos, Itacoatiara, or Para, small river steamers are despatched up the various rivers, to bring down the nuts which clients have ready piled up in shacks on the river bank, or, in the case of larger nut-producing centres, as much as can be loaded in the holds or in the barges towed alongside.

Although new crop nuts frequently begin to arrive at Manaos during December, the principal crop months on the Amazon are from February onwards, and the heaviest are generally in March or April. During these months the steamers are turned round at Manaos and Para as quickly as possible and sent up river again. In spite of this they can only make a limited number of voyages into the interior, owing to the vast extent of the two States, Amazonas having an area of 732,000 square miles, or six times the size of Great Britain and Ireland, and Para, covering 444,000 square miles, or three and a-half times the same area.

With small crops the yields are all brought down and marketed by May or June, but during the last two years, when the nut harvest has been particularly abundant, large quantities have been received at Para and Manaos as late as September and even October, while smaller quantities continued to be brought down from the interior right up to the end of the year.

Of the 1922 yields approximately 15,000 tons were handled at Para, while over 18,000 tons were handled by Manaos exporters, and shipped from Manaos or Itacoatiara ; of the latter fully 15,000 tons were so-called large washed nuts.

From certain districts, which are inaccessible by steamboats, the nuts are brought by pack-mule at very considerable expense, with the result that when prices do not justify the expenditure, crops are abandoned altogether.

When the nuts reach the buyers in Manaos or Para, the greatest care is taken to prevent deterioration. The parcels are shovelled over riddles to remove any earth or nut-dust, and any damaged or mouldy nuts are picked out carefully.

Experience has taught shippers that nuts are best imported in bulk, and steamers built for the Booth Lines, which have practically the monopoly of the trade, are splendidly adapted for this purpose. The nuts, when loaded, are tightly partitioned off, according to grade and ownership, in order to avoid confusion on arrival. The company provides good ventilation, and turns them over and over during the voyage to avoid sweat, which causes the nuts to deteriorate and become mouldy. Mould is much to be feared; it spreads rapidly in an inexplicable manner, affects the kernels, and detracts from their value. Brazils are hardly ever shipped in bags, partly because the loss in weight—always a considerable item—is thereby increased.

On their arrival in the United Kingdom, splendid quay accommodation for landing and handling is placed at the disposal of the consignees by the Booth Line at Liverpool. It is an interesting sight to see the immense shiploads of 1,500-2,000 tons that were dealt with in April and May of this year. The nuts are raised out of the hold in baskets by cranes, and swung into well-ventilated sheds, where they are dumped in piles. All defective nuts are picked out, and, if the goods have been sold, they are bagged up in sacks of 1 cwt. to 2 cwt. in weight, and despatched. Those unsold are again bulked in well-ventilated warehouses. There they are continually turned and picked over, to keep them in good condition until required for consumption, which may be months later.

The large yields of the past few years are largely due to the depressed state of the rubber market on the Amazon, formerly a source of wealth to that enormous but sparsely populated region. Many of the rubber plantation employees have now emigrated, but many others have taken to the nut-gathering industry as a more profitable means of livelihood.

Although it is rather early to make a forecast of next year's crop, the information so far available from the Amazon indicates another heavy yield for 1923.

SECOND WORLD'S POULTRY CONGRESS AND EXHIBITION.

THE Second World's Poultry Congress and Exhibition will be held in the City of Barcelona on May 10th 1924 and continue until May 17, the former concluding in Madrid. The Executive Committee request us to give publicity to the above fact and to invite offers as soon as possible of papers and communications to be read at and submitted to the Congress. These should represent educational, investigational and official work, and projects for extensions. A leading object is to bring into one focus the knowledge already available in all countries.

With respect to the Exhibition, this will be demonstrative not competitive. In the live poultry each country is invited to send specimens of the breeds indigenous to it, and these which have proved most profitable, whether for food production, exhibition or ornamental. In this manner a complete exhibition will be made of all known breeds of poultry.

In the general sections of the Exhibition, displays are invited indicative of instructional, investigational and research work, of appliances in poultry husbandry and of accessory materials and products, as well as of books and publications. Manufacturers of appliances, etc. will be able to shew their goods under favourable conditions. A supply of the programme and regulations are expected shortly when the Department of Agriculture will be pleased to forward copies to those interested in this event.

Arrangements for the triennial Poultry Congresses is in the hands of the International Association of Poultry Instructors and Investigators. The Department of Agriculture Federated Malay States and Straits Settlements is a Patron of this Association, and would be pleased to assist as far as is in its power any gentlemen wishing to attend the Congress and Exhibition as official delegates, or representatives of public bodies and institutions engaged in instruction, experimental work and research, Poultry and Agricultural Societies,. trade organizations, or of poultry breeders.

28th February 1923

NOTICES.

Groundnuts.

The Department of Agriculture, S.S. and F.M.S. has obtained addresses of local buyers of groundnuts both shelled and unshelled.

Growers of this legume who wish to dispose of their crop should communicate with the Agriculturist, Department of Agriculture, Kuala Lumpur.

If a sample is forwarded to this Department a price will be quoted.

Roselle Seed.

(HIBISCUS SABDARIFFA VAR: ALTISSIMA).

The Department of Agriculture, S.S. and F.M.S. has reduced the price of Roselle seed from \$3/- to \$2/- per lb.

10th March, 1923.

ERRATA.

Vol. X Nos. 10—12.

Kapok Oil page 285 *for* Nitrogen 8.08 per cent *read* Nitrogen 3.98 per cent.

Previous Sample Kuala Kangsar *for* Density ·918 *read* density ·919.

Cashew Nut Oil, page 301 *for* Oil 38.5 per cent *read* oil 43.5 per cent.

THE

Malayan Agricultural Journal.

Vol. XI March, 1923. No. 3.

PRELIMINARY AND INTERIM REPORT ON INVESTIGATIONS ON THE PRODUCTION OF ALCOHOL FROM NIPAH PALMS.

By B. J. Eaton and J. H. Dennett.

In connection with the possibilities of the production of power or fuel alcohol from local raw products, attention has been confined during the year to investigations on the Nipah Palm (*Nipah fruticans*).

Existing areas.

The following information in respect of areas of indigenous Nipah Palm has been supplied by the Conservator of Forests F.M.S. and S.S.

Perak North. Province Wellesley and Penang.

District.	Forest Reserve Acres	State Land Acres.	Alienated Land Acres	Total Acres.
Penang ...	...	...	200	200
Province Wellesley	...	...	1,800(*c*)	1,800
Matang and Krian	100(*a*)	100(*a*)	2,300(*b*)	2,500
	100	100	4,300	4,800

(*a*) The Nipah in forest reserves and state land is estimated only and is in small scattered patches.

(*b*) The areas given for alienated land in Perak are those shown in the titles of owners. The actual nipah is considerably less and for practical purposes is estimated at not more than 1,500 acres.

(*c*) No figures supplied by District Officer, Butterworth: estimated at 400 acres.

Perak South.

Total area estimated at approximately 8,000 acres, of which 7,600 acres are in Perak and 400 acres in Selangor. Roughly 75 per cent of this is alienated and the balance is State land. The area in reserves is practically negligible.

SELANGOR (COAST DISTRICT).

Klang District—

		Acres.
State Land on banks of rivers	...	... 5
Alienated Land	...	... 1,313
Forest Reserves — Jugra Block II	...	... 100
Forest Reserves — Jugra Block I	...	... 25
Forest Reserves — Teluk Gedang	...	... 5
Forest Reserves — Pulau Lumat	...	... 150
	Total	... 1,598

Kuala Selangor District—

		Acres.
State Land on banks of rivers	...	... 10
Alienated Land	...	... 656
Forest Reserve (Banjar Block II)	...	... 2
	Total	... 668

Kuala Langat District—

		Acres.
State Land on banks of rivers	...	... 3
Alienated land	...	... 625
	Total	... 628

Grand Total (Selangor) 2894 Acres.

NEGRI SEMBILAN.

		Acres.
State Land Sungei Raya	...	... 5
Alienated Land P. Kempas	...	... 200
Sungei Menyala	...	... 50
,, Rembau	...	... 200
Forest Reserve (Linggi proposed reserve)		... 50
	Total	... 505

PAHANG.

				Acres.
Pahang West	...	...	...	Nil.
,, East	...	...	...	3,000 (estimated)

The area of nipah in reserved forest and on alienated land in Pahang East is practically negligible.

It is very difficult to estimate the area on state land. Certain parts of the banks of all the rivers carry Nipah, the streams in the southern part of the State being especially well supplied.

The area on the Anak Endau is rather large and is believed to contain as much nipah as the rest of the State.

There is a good deal on the Pontian. On the Rompin, the palm is found for a great distance up stream, but the strips are rather narrow.

As a rough estimate and with no pretensions to accuracy, the total area in Pahang East is about 3,000 acres.

Malacca.

		Acres.
Crown Land (near Rembau)	...	30
Alienated Land (Central District)	...	100
Forest Reserves (Sungei Lingga proposed reserve)	..	20
Total	...	150

Objects of Investigations

In order to carry out and supervise tapping experiments and at the same time to undertake laboratory investigations of the sap or saccharine juice obtained by tapping the fruiting stalk it was necessary to select an area within reasonable distance of the laboratories. A number of areas on the small islands off Port Swettenham and other areas between Klang and Kuala Selangor were visited and it was eventually decided to select an area at the 15th mile Klang—Kuala Selangor Road and also to continue tapping observations on certain palms at Jeram.

The principal objects in view are:—

(1) Determination of yields of sap and period of tapping.

(2) Investigation of the composition of the sap and the changes which the sap undergoes during and after collection.

(3) Methods of planting.

Observations in connection with yields are rendered difficult by the fact that (*a*) it has not been possible to keep the tapping experiments under the continuous supervision of a European Officer (*b*) the history, age and previous treatment of indigenous palms is unknown.

With the exception of a few palms at Jeram, no suitable areas could be found on which palms had not been cut previously for attap. This cutting of the fronds has almost certainly a marked effect on the yields of sap

Observations in connection with the composition of the juice are rendered difficult by the rapid changes which occur even during collection, necessitating investigations of a laboratory character on the spot.

Situation of Experimental Areas.

During the year three areas have been under observation as follows:—

Area A. Situated on the east of the Klang—Kuala Selangor Road at the 19½th mile (near Jeram).

The palms on this area are privately owned by a Malay (Haji Osman) and have been planted regularly in drains and may be described as cultivated palms.

Area B. Situated on the west of the same road, close to the coast at the 20th mile. This appears to be a "self planted" area.

Area C. Situated on the west of the same road, and adjoining the road at the 15th mile.

Description of Areas.

Area A. The palms on this land are planted at regular intervals in drains in a mixed Kampong.

According to Malays, palms planted in drains are growing under optimum conditions, due to the constant supply of water, except in very dry weather.

The palms on this land are very healthy in appearance and well cared for by the Malay owner, who appears to have a considerable knowledge of methods of treatment of the palm and the methods of tapping.

The height of some of the palms is about 45 feet, but the age is uncertain. They are said to consist of two varieties or types—Nipah Gala and Nipah Padi, the principal botanical or anatomical differences between the two types being the variation of the angle at which the leaflets emerge from the main stem or midrib of the fronds.

Area B. The palms on this area are growing in more or less swampy land near the coast. They are generally stunted in growth and have been extensively cut for attaps.

The results obtained from tapping on this area are of little value from the point of view of yields. This may be attributed partly to the difficulty of access, in consequence of which the preliminary treatment (gonchang) of the fruiting stalk was not systematically carried out. In addition, personal feuds between local Malays prevented work being done by men who were most conversant with the methods of treatment of the palm.

Area C. This area may be divided into two portions (1) an area of comparatively high ground on which water is obtainable by the palms chiefly during the monthly high tides, when the land is under water. The palms on this area are stated to have been planted by a Chinese in 1916 for the purpose of cutting for attaps. (2) An area of indigenous palms, a few of which (about six) were growing in small drains.

It is of interest to note that the average yield of sap from the latter was about seven or eight times the amounts obtained from the palms on the higher ground, although the highest yields were small in comparison with those of palms on Area A.

This area has also been utilised for the experimental planting of seedling palms.

Tapping Experiments.

Tapping has been carried out by two local Malays (Haji Osman, the owner of Area A, and Haji Suleiman).

The tapping of the fruit stalks has been preceded by the preliminary treatment of the fruit stalks. known as the "Gonchang" process. which is the only process known by the local Malays.

Later in the year, attempts were made to tap the flowering stalk or spathe before it opens, a method stated to be practised in Sarawak, but the experiments were uniformly unsuccessful.

Since these latter experiments were initiated, information has been received from the Conservator of Forests, British North Borneo, who states that this method of tapping has been tried by his forest rangers with the result that *for a few days a good flow of juice was obtained after which the stalks dried up.*

He stated further that the best results were obtained when the fruit on the stalk was about half mature.

According to local knowledge and practice it appears that the process of "Gonchang" should be commenced when the fruit bunch or head has a diameter of 6-7 inches, the preliminary treatment of the stalk lasting from 1½ to 3 months, according to the growth and character of the fruit.

The results are also stated to be modified by the treatment given to the epidermis of the stalk, which should be cut away in wet weather, and left on the stalk if the treatment is carried out during dry weather.

In order to endeavour to reduce the period of preliminary treatment which, according to local Malay knowledge, is essential and which appears to be confirmed by our tapping experiments, it has been arranged to carry out further tapping experiments of both the immature or flowering stalk and the more mature or fruiting stalk by

practising the preliminary treatment accorded to the flowering spathe of the coconut palm when tapping for toddy. This preliminary treatment requires a period of about two weeks.

If a more successful and shorter period of preliminary treatment can be discovered, it will be a great advance and of considerable importance from the point of view of saving of labour in the commercial tapping of the palm.

Summary of Experimental Yields.

A summary of experimental yields obtained is given in Tables I, II and III attached

An interpretation of the variation of these yields is rendered difficult by the comparatively large number of unknown factors involved such as (*a*) the health of the palms and previous history (*b*) age of palms, (*c*) foliage (*d*) water supply (*e*) methods of treatment.

No yields of palms on Area B are given, since the figures are, in our opinion, valueless, owing to the lack of systematic preliminary treatment of the palms before tapping.

A correct interpretation of the yields on Area A is also difficult, in consequence of the illness of the owner during the tapping period and the subsequent resumption of tapping by a less experienced tapper.

The following observations are offered on the results obtained.

Area A. The yield from palms Nos. 1, 2 and 3 on Area A may be regarded as very satisfactory. The tapping of these palms was carried out during the early part of 1922 under continuous supervision and all the palms had been "gonchanged" for periods of 2–3 months.

Palm No. 1 also received regular attention and yielded about ½ gallon of sap per day. The yield of palm No. 5 was very low; this palm is stated to have fruited for the first time.

It is also believed that the character of the internodes of the fruiting stalk in respect of length, has a considerable influence on the yields The yields drop considerably near the nodes.

Table IV attached showing yields of Palms No. 6 and 7 illustrates the drops in yield at the nodes and the subsequent increases.

Area B.—The yields on this area are all poor, which is attributed to inefficient preliminary treatment of the fruit stalks before tapping.

Area C.—Most of the palms on this area are poor in growth and have been cut previously for attap. Nearly all of them are also planted on comparatively high ground, and obtain sufficient moisture only during rainy weather and at high tides.

With the exception of Palms Nos. 19, 21, 22, 23, 29 and 30 the yields are almost negligible. The better yielding palms are still giving

a comparatively good flow of juice, compared with other palms on this area. In our opinion the better yields of the six palms mentioned above are due to the fact that they are growing in drains and consequently have a better water supply.

Summary of Observations on Yields.

The yields obtained from the palms on area A show that satisfactory yields (say ¼—⅓ gallon of juice per diem) can be obtained from good palms under proper conditions of treatment and tapping. The poorer yields obtained on other palms later in the year are attributed to inefficient treatment of the palms due to the illness of the owner and the fact that a less skilled operator had to be employed.

It is not possible at the present stage to give any definite opinion on the average yields which are likely to be obtained continuously on a large scale, since the yields obtained in these experiments are for the period December 1921—March 1922 on some palms and for October 1922 —December 1922 on others.

In order to obtain a more accurate idea of the yields per acre per annum, further observations are necessary on the actual number of fruit stalks which reach maturity during a period of at least twelve months and also, if practicable, to tap and measure the yields of juice obtained from such fruit stalks.

The latter however is not so important, in our opinion, as the former. In this connection it may be stated that one clump of four derived from one seed had thirteen fruits at one period in different stages of maturity while three clumps were observed with ten stalks each and several others with seven stalks, although the average number at any given time appears to be from three to four stalks.

The tapping experiments show that yields of ¼ to ⅓ gallon per palm per diem can be obtained under good conditions and all enquiries addressed to local Malays have elicited the information that the palms will yield about two chupahs per day.

It should however be pointed out here, that it is highly probable that apart from variation in yields due to the method of treatment and tapping, there will be considerable variations in yields from individuals palms due to hereditary factors as in the case of other economic plants and that yields can probably be improved by methods of selection. In the commercial exploitation of this palm, there are at present a number of unknown factors, in connection with the cultivation and yields, which are present especially in all agricultural enterprises.

Chemical Investigations on Juice.

Chemical investigations on the changes which the juice undergoes during and after collection have been carried out during the year.

According to Gibbs, in the Philippines, by using clean glass vessels for collection of the sap, inversion of the cane sugar in the sap is completed and the alcholic fermentation has reached its maximum at the end of about 17 hours.

Our investigations however show that the conditions in Malaya which affect the inversion of the sugar and the fermentation to alcohol are different. These results are surprising in view of the more tropical conditions in Malaya compared with the Philippines.

In experimenting on the fresh juice it appeared desirable to carry out investigations, as far as possible, on the spot, in order to avoid changes in the juice during transit.

Experiment 1.—This experiment included observations on the changes in density of the fresh juice during a period of nearly forty eight hours (excluding a night interval for sleep.)

Full details of these observations are omitted from this report, but they show the following results :—

The original specific gravity of the juice (28 minutes after tapping) taken at 10 a.m., at 25 °C was 1.0588 (compared with water = 1.000) which corresponds to a saccharose (cane sugar) content of 15.41 per cent. This figure was confirmed subsequently by means of a saccharimetric reading. The acidity of the liquid was nil. At 2 p.m. the density had increased to 1.0589 and at 2.30 p.m. fermentation was indicated by the evolution of bubbles of carbon dioxide; at 3 p.m. the density had risen to 1.0590. These increases in density are probably due to the inversion of the saccharose which on inversion absorbs 5.25 per cent of water.

$C_{12}H_{22}O_{11}$	+	H_2O	=	$C_6H_{12}O_6$	+	$C_6H_{12}O_6$
Saccharose		Water		Glucose		Fructose

At 4 p.m. the acidity of the juice amounted to 0.165 per cent. calculated as acetic acid.

At 9.15 p.m. the temperature had dropped slightly, but the density had decreased to 1.0585 showing that fermentation of the sugars to alcohol was proceeding. The acidity (as acetic acid) had increased to 0.24 per cent. The density of the juice was taken at further intervals during the night and by 11.30 a.m. on the following morning had only dropped to 1.0440 which showed that, even after 24 hours, the juice still contained about 11 per cent. of sugar (saccharose or invert sugar or both); at 7.30 a.m. on the following day (i.e. 45 hours after tapping) the density had only dropped to 1.020, indicating the presence of about 6.5 per cent of sugar.

Owing to the divergence of these results from Gibbs' experiments in the Philippines, a further confirmatory experiment was carried out.

Experiment 2.—A quantity of juice was collected and aliquot portions taken at intervals during 24 hours at the same place at which Experiment No. 1 was carried out.

These portions were run into a known excess of 96 per cent alcohol to arrest fermentation.

It was found that the sample removed at the end of 24 hours still contained 9.3 per cent of saccharose.

This result is important and shews that the fermentation in Malaya is easier to control than in the Philippines, provided glazed collecting vessels are used.

It has not been possible so far to carry out similar experiments with juice collected in bamboo vessels, but this will be done later.

It may be noted here, that the control of fermentation necessary for the manufacture of alcohol, must not be confused with the control necessary if sugar is to be manufactured, since the latter is a much more difficult proposition.

Experiment 3. -In view of the importance of the amount and character of the mineral salts present in the juice, in connection with the manufacture of sugar, a qualitative and quantitative analysis of the mineral matter is being undertaken. In the course of the concentration of juice in order to obtain the ash, further confirmation of the slow fermentation of the sugar, mentioned above, was obtained.

It was considered desirable, in order to avoid the large amount of carbonaceous matter, which would be produced on evaporation and ignition of the more or less fresh juice, to estimate the ash on old fermented juice. A sample of juice at least one month old was however found to contain large quantities of sugar in addition to acetic acid and traces of ethyl acetate.

This is probably explained (a) by an equilibrium in the system—sugar—alcohol—ethyl acetate-acetic acid (b) by the formation of a scum on the surface of the liquid which excludes air and prevents further fermentation and (c) destruction of the organisms present when the products of fermentation attain a certain concentration.

Qualitative analysis of the juice has shown the presence of the following elements—calcium, iron (traces) aluminium, magnesium, sodium and potassium, phosphates, sulphates and silicates.

Experiment 4.—The variation of the sugar content of the juice was determined on different dates and from different palms.

The results, which are given below, were determined by estimations carried out on the fresh juice about an hour after collection.

Sugar Content of juices of three Palms (Nipah Padi)

On first day of flow.

(1) 14 0 per cent. (2) 14.6 per cent. (3) 14.75 per cent.

Other Nipah Padi palms gave the following results:—

No. (1)	17.7 per cent.	No. (6)	16.3 per cent.
„ (3)	17.2 „	„ (10)	16.3 „
„ (5)	17.1 „	„ (11)	13.3 „

Repeat tests carried out on consecutive days gave the following results:—

Palm No. 1	One day	17.7	per cent.	
„ „	Next day	19.7	„	
„ „ 10	One day	16.3	„	
„ „	Two days later	11.5	„	(after heavy rain)

The following results were obtained on the juice from three stalks on palm (A) on Area A.

	Stalk 1	Stalk 2	Stalk 3
Sugar per cent.	11.5	14.6	14.0
„ „	12.1	10.1	10.1
„ „	16.8	13.8	14.2
„ „	12.8	13.5	14.0
„ „	13.0	12.5	13.9

In the case of two other palms (B & C) on this area, single estimations gave sugar contents of 13.9 and 14.2 per cent respectively.

An average sugar content of 12.5 per cent may be taken as a sound estimate.

Further determinations were carried out later in the year on the juice from palms on Area A.

The method employed was as follows: —

Small graduated flasks containing known amounts of absolute alcohol were attached to the Nipah stalks, so that the juice dripped direct into the alcohol, whereby formentation and inversion of the sugar was arrested. The samples thus collected were examined in the saccharimeter.

The following are some results obtained.

Day	Palm No.	1	2	3	4
1	Sugar (Per cent.)	12.1	14.2	10.1	13,65
2	„ „	11.2	12.7	9.8	11.75
3	„ „	10.8	13.75	8.8	13.07

These figures show that the quality of the juice in respect of sugar content varies from palm to palm and from day to day.

Production of Alcohol and Sugar.

Alcohol.—As stated above, natural alcoholic fermentation is far from complete after 24 hours, if glazed collecting vessels are used. A certain amount of ethyl acetate will also be formed, but this will not materially affect the quality of the alcohol for power or fuel purposes.

It is not anticipated that the manufacture of alcohol from the juice will present any considerable difficulties.

Sugar.—The manufacture of sugar of high quality and colour from the juice of the Nipah palm does however present certain difficulties. It is not possible to carry out any satisfactory quantitative

work in the laboratory on the yield and production of a high grade sugar, owing to the difference between laboratory and large scale practice.

Determinations of the purity of the juice will however indicate closely the percentage of first grade sugar which should be obtainable. The most generally applicable method of preservation of juice during collection is by the addition of lime in order to maintain an alkaline reaction.

It has been found that about 30 grammes of lime per litre of juice are necessary to preserve it completely. This amount is comparatively large and must be eliminated after the juice reaches the factory. It has been found that this can be accomplished fairly easily by means of settling tanks or vessels, in which the lime and matter precipitated with the lime sinks to the bottom of the vessels. It may prove economical to reburn and recover the lime. After this preliminary settling there will however be still a large excess of lime in solution, beyond the amounts usually present in cane sugar practice.

This lime may be removed by (a) carbonation or (b) treatment with alum.

The following experiments is this connection have been carried out: —

(*a*) The juice was heated and carbon dioxide passed through the solution until the precipitation of calcium carbonate was complete. The calcium carbonate was allowed to settle and the clear, almost colourless, supernatant liquor was concentrated under reduced pressure.

The colour of the liquor darkened as the concentration increased and the characteristic odour due to the presence of certain organic nitrogenous constituents developed. No nitrogenous material appears to be removed from the liquor during concentration. Four crystallisations of the resulting sugar were necessary to remove the odour and even then it appeared again, after the sugar had been standing for several days. The elimination of these odoriferous constituents requires further consideration.

(*b*) Method (b) at first sight appears to have many advantages over method (a). The essential feature of this process is that excess of lime is precipitated by the alum as calcium sulphate, while aluminium is precipitated in the form of flocculent alumina and the precipitate "drags" down a large amount of the soluble nitrogenous substances and colouring matter present in the juice.

The precipitate produced is however very voluminous and does not settle readily, even after standing for several days. By centrifuging however the liquor

may be cleared completely in about half an hour and the clarified juice so obtained is practically colourless.

On concentration however, periodic precipitation of calcium sulphate etc. occurs, which renders the method not so simple in practice.

Summary of Results.

1. The production of alcohol from the juice of the Nipah Palm should present no considerable difficulties, although it remains to be considered whether natural fermentation alone or aided by the addition of yeast cultures to the collecting pots will be more economical or efficient than attempting to collect a sterile juice with subsequent controlled fermentation in a central factory. It is believed that the latter may present too many difficulties, although it may prove satisfactory to sterilize the partly fermented liquor on reaching the factory and to complete the fermentation under control.

2. The production of a high grade sugar will present greater difficulties, especially in connection with the collection of a juice in which the saccharose has not become inverted during collection.

Further investigations are required in connection with (a) the elimination of the organic nitrogenous substances present in the juice, which appear to remain persistently in the sugar, as judged by the odour, and also in connection with (b) the quantitative investigation of the ash or mineral matter, which will affect the yield of first quality or crystallizable sugar.

3. The yields of juice obtained by tapping a number of palms are at present too variable to form an accurate estimate of probable yields of juice per acre, although it is possible to obtain yields of ¼ to ⅓ gallon per palm per diem.

4. On the information at present available both in the Philippines and from the comparatively small number of experiments carried out locally, the cultivation of the palm must still be considered in the nature of an agricultural speculation of considerable promise.

Cultivation.

Owing to the fact that every area of Nipah Palm so far examined has been cut previously for attap and is of unknown age and history, it has been considered desirable to acquire two small areas for planting seeds, in order to make observations on the growth and to ascertain the age at which the plants mature, which is said to be in 3—4 years from planting of seed.

One area has been acquired at the 15th mile, Klang—Kuala Selangor Road where the soil is washed by tides and the drainage water is brackish and the other area about 2 miles from Telok Anson on the Bagan Datoh Road where the soil is not affected by salt water. The two areas have been selected in order to ascertain whether the palms thrive best on soil affected by salt or fresh water.

Planting Methods.

Theoretical considerations of yields have hitherto been based on a planting distance of 12 ft. × 12 ft. giving almost exactly 300 palms per acre.

This distance appears to be suitable from the point of view of growth, although not from the point of view of transport of juice.

For transporting large quantities of juice to a central factory, it is probable that mechanical transport of some kind will be essential or the construction of pipe lines or flumes connected with large collecting tanks in the fields.

If the latter are adopted, a planting distance of about 12 ft. × 12 ft. should prove satisfactory but to allow for transport a distance of 12 ft. × 16 ft. will be probably more satisfactory.

The seeds or seedlings are planted preferably in drains or more correctly in the sides of drains or in openings cut out from the sides of drains.

A satisfactory method is to dig drains about 2 feet deep by 2 feet wide (the depth should vary according to the water table).

Every twelve feet along the drains the width is extended to four feet.

It has been found also that the young palms require shading and, since land suitable for planting the palms is frequently covered with blukar, it is preferable to leave much of this growth on the land, until the palms are well established. At a later stage the blukar can be cut down. The palms will eventually shade the ground sufficiently to prevent growth of weeds to any extent.

The cost of preparing the land by the construction of drains as above can easily be ascertained and can, if desirable, be carried out on contract. The cost of planting the seeds is small and the cost of upkeep on land of suitable character should be comparatively small.

It is probable that it may be desirable on many areas to regulate the water supply by means of water gates etc.

Received for publication March 23rd 1923.

TABLE I. (AREA A.)

Palm.	Number of Stalks.	Per day Highest yield per stalk.	Per day Lowest yield per stalk.	Per day Mean yield per stalk.	Period. Stalk 1.	Period. Stalk 2.	Period. Stalk 3.	Per day Highest yield per tree.	Per day Lowest yield per tree.	Per day Mean yield per tree	Remarks.
		ccs.	ccs.	ccs.				ccs.	ccs.	ccs.	
1	3	2035	620	920	Dec. 8th 21 to June 22nd 22	Dec. 8th 21 to May 30th 22	Dec. 8th 21 to June 24th 21	5585	890	2460	This palm appears at first sight excellent. It will be noted however that the mean yield per stalk is not extraordinary.
2	1	1680	675	1400	Unknown	. ...	......	1680	675	1400	Records incomplete.
3	1	1655	560	1200		. ...	... ..	1665	560	1200	Records incomplete.
4	2	1367	10	515	Sep 7th 22 to Dec 22nd 22	Oct. 6th to Dec 22nd	... ..	1910	90	1030	.....
5	1	430	15	170	Nov. 8th to Dec. 8th	......	..	430	15	170	Bad stalk, broken.
6	1	1140	20	385	Sept. 30th to Dec. 22nd	. ...	.. .	1140	20	385	Stopped tapping.
7	2	750	5	186	Sept 27th to Dec 22nd	... .	......	1060	5	372	Finished.
8	2	1080	5	400	Sept. 15th to Sep 18th	Oct. 1st to Dec. 22nd	... ..	1080	10	400	......
9	2	1410	5	300	Sept. 30th to Dec. 22nd	Oct 15th to Nov. 11th	......	1595	120	600	Mean yield per stalk reached on one stalk only. Stalk 1 only, yielding 105 ccs.
10	1	395	10	144	Oct 20th to Nov. 9th	... ..	..	395	10	144	Still flowing.
11	1	350	10	117	Oct. 4th to Nov. 3rd	...	.. .	350	10	117	.....
12	1	50	5	28	Nov. 3rd to Nov 9th	...	... .	50	5	23	First year of tapping.

AREA (B)

TABLE II.

Palm.	Number of Stalks.	Highest yield.	Lowest yield.	Mean yield.	Time of flow in days.	
		ccs.	ccs.	ccs.		
1.	1	30	30	30	1	
2.	1	106	21	60	8	
3.	1	146	8	110	14	
4.	2	70	15	35	6	
5.	1	245	15	98	21	
6.	1	22	10	19	1	
7.	2	160	15	80	14	
8.	1	10	10	10	1	
9.	1	65	15	33	5	
10.	1	10	40	40	1	
11.	1	210	10	72	22	
12.	2	386	10	162	28	
13.	1	230	25	100	14	
14.	1	55	10	33	5	
15.	1	28	10	20	3	
16.	1	54	5	27	6	
17.	1	56	10	28	10	
18.	1	60	10	33	8	
19.	2	812	134	524	22	Still yielding
20.	1	62	32	48	5	
21.	1	880	120	327	31	Still yielding
22.	1	458	32	202	24	„
23.	1	390	25	250	31	„
24.	1	156	15	47	20	
25.	1	120	12	70	9	
26.	1	234	10	80	21	
27.	1	28	10	29	10	
28.						
29.	2	560	100	284	31	Still yielding
30.	2	700	260	485	27	„

TABLE III.

SECOND SUMMARY OF AREA (A).

Palm.	Time of flow in days.	Juice in Gallons.
1.	201	111.3
2.	—?	* (1/8 gallon per day)
3.	—?	* (1/3 gallon per day)
4.	87	19.8
5.	80	1.1
6.	84	6.7
7.	87	7.0
8.	83	7.5
9.	81	11.2
10.	20	0.6
11.	30	0.8
12.	6	0.4

* Yields taken for about 2½ months; observations on total tapping period incomplete.

AREA (A).

TABLE IV.

Date.	Palm 6.	Palm 7.	Date.	Palm 6.	Palm 7.
	ccs.	ccs		ccs.	ccs.
27- 9-22	—	600	30-10-22	20	520
28- 9-22	—	800	31-10-22	25	480
29- 9-22	—	1053	1-11-22	45	565
30- 9-22	204	814	2-11-22	50	10
1-10-22	487	872	3-11-22	40	320
2-10-22	603	931	4-11-22	45	270
3-10-22	800	929	5-11-22	65	300
4-10-22	850	845	6-11-22	60	260
5-10-22	892	887	7-11-22	5	80
6-10-22	748	813	8-11-22	15	210
7-10-22	695	1060	9-11-22	10	290
8-10-22	870	830	10-11-22	5	200
9-10-22	830	670	11-11-22	60	..
10-10-22	1050	830	12-11-22	385	110
11-10-22	870	755	13-11-22	360	340
12-10-22	1180	800	14-11-22	230	265
13-10-22	915	750	15-11-22	190	230
14-10-22	940	745	16-11-22	170	180
15-10-22	425	465	17-11-22	310	270
16-10-22	450	300	18-11-22	50	30
17-10-22	225	300	19-11-22	110	130
18-10-22	165	460	20-11-22	210	270
19-10-22	155	485	21-11-22	130	30
20-10-22	510	760	22-11-22	160	130
21-10-22	385	475	23-11-22	40	270
22-10-22	560	485	24-11-22	240	110
23-10-22	540	640	25-11-22	150	130
24-10-22	890	650	26-11-22	550	50
25-10-22	490	620	27-11-22	520	160
26-10-22	390	590	28-11-22	380	370
27-10-22	260	570	29-11-22	230	310
28-10-22	50	580	30-11-22	100	310
29-10-22	20	440	—	—	—

PRELIMINARY NOTE ON THE TWO COLOURED COCONUT LEAF BEETLE, (*Plesispa Reichei*, CHAP).

By G. H. Corbett.

THIS insect belongs to the sub-family *Hispinae* of the family *Chrysomelidae* and is an important pest of the coconut palm in Malaya.

Maulick in his Fauna of British India gives a list of the *Hispinae* known to attack cultivated crops and enumerates the following as injurious to the coconut palm.

Promecotheca cumingi, Baly. Philippine Islands. Young shoots of coconut.

Promecotheca reichei, Baly. Samoa. Coconut.

Promecotheca opacicollis, Gestro. New Hebrides. Coconut.

Promecotheca coeruleipennis, Blanch. Fiji. Coconut.

Promecotheca antiqua, Weise. New Guinea and Solomon Islands. Coconut.

Bronthispa froggatti, Sharp. Solomon Islands. Coconuts.

It was considered that the larvae of all *Hispinae* were leaf miners but further observations have shown that the larvae of *Bronthispa froggatti*, Sharp., *Plesispa reichei*, Chap. and *Plesispa nipa*, Maulick, live on the epidermis of the leaf.

Froggatt* writing of *Bronthispa froggatti*, states that "the larvae of the beetles of this genus are not leaf miners but feed with the adult beetles upon the epidermis of the opening leaf-buds protected in the half-folded fronds."

Plesispa reichei and *Plesispa nipa*, the latter was found on nipah and sago palms near Malacca in 1921, have habits similar to *Bronthispa froggatti*, and the observation made by Froggatt concerning the larvae of the genus *Bronthispa* not being leaf miners will probably be found to hold good for the habits of the larvae of the genus *Plesispa*.

Literature concerning *Plesispa reichei* in Malay is exceedingly meagre presumably due to this insect not being so widely distributed as at present.

The first probable reference is contained in the Report of the Director of Agriculture for 1912 under the heading of Pests of Coconuts.

***1914—15. Froggatt, W.W., "Bulletin Entomological Research" V. page 151.**

"A small beetle was received from Johore belonging to the *Hispinae*. It was found in abundance, on coconuts and planters should keep an eye for it, in case it comes into the Federated Malay States. It has been a serious pest in the Philippines and can be recognised by its very flat shape, its yellow head and thorax, and bluish black wing-cases."

This insect is now generally distributed throughout Malaya.

General Descriptions of the Stages.

(1) *Adult.*

The beetles vary from 5—7 mm. in length.

The colour of the head, frontal projection, and antennae is dark brown. The prothorax is yellowish brown, the wing covers are black, and the abdomen in the middle, dark and at the sides, dark yellow.

The size of the insect frequently gives an indication as to the sex but the following characters should be verified before determination is made.

In the female, the frontal projection is broad at base, pointed at the apex, and compressed laterally. In the male, the frontal projection is slightly longer than in the female, slightly concave at sides, and about as broad at apex as at base. In the male the last abdominal sternite is more emarginate than in the female.

(2) *Egg.*

The egg is reddish brown in colour, about 1.75 mm. in length and .75 mm. in breadth. It is oblong ovate in shape and its upper surface slightly convex. The upper surface is partly covered with pieces of a pale yellow substance resembling leaf tissue.

(3) *Larva.*

The larva is flat, slightly convex, and dirty white or yellowish in colour. Full grown it is about 8.5 mm. long and 3 mm. broad.

There are eleven pairs of lateral projections, two pairs from the mesothoracic segment, one pair from the metathoracic and from the next eight segments.

The anal segment terminates in two caliper like projections and has on the dorsal surface a pair of spiracles.

(4). *Pupa.*

The pupa is flat, about 8 mm. in length, and at first of a pale yellow colour later changing to a deeper yellow. A pair of lateral projections arises from each of the seven abdominal segments. The last larval skin remains attached to the last abdominal segment of the pupa.

The approaching emergence of the beetle is indicated by the darkish colour of the wings showing through the elytra.

Manner of Feeding and Nature of Injury.

This insect, both in the larval and adult stages, feeds upon the upper and lower surfaces of the coconut palm leaves.

The whole period of its attack is confined between the folds of the tender leaves whilst they are still partially folded up.

Neither the grubs nor the beetles move far from the feeding places. They feed in a straight line without interruption, but, having advanced a certain distance, frequently turn round and feed in the opposite direction on the surface of the leaf parallel to the former feeding mark. Later, these feeding lines mingle with each other so that the remaining tissue dries and rots. Finally, the leaf tears and the young plants take on a peculiar weather beaten appearance and their growth is seriously retarded. If the attack has been severe and of long duration the plants die.

Age of Trees Attacked.

This insect is essentially a pest of seedlings in the nurseries and young plants in the field up to two or three years of age. When seedlings a few weeks old are attacked, most damage is done, but, on older plants, unless the grubs and adults are in large numbers, the injury is not of such great importance on account of the more extensive leaf surface.

Owing to the difficulty attending their examination, it has not been definitely ascertained if *Plesispa reichei* is generally distributed on older trees. The characteristic appearance described above of the palm leaves from the ground is difficult to see, but occasionally leaflets of the central leaves adhering to each other have been observed and on their examination this insect has been found.

Plesispa reichei has been collected from trees of eight, ten, and thirteen and a half years of age, and from an old tree at least 50 ft. high. In all cases, however, the trees appeared to have suffered from some previous injury or were growing in unhealthy conditions.

Host Plants.

A large number of different palms—ornamental and jungle-has been examined but though other Hispid beetles have been obtained the only other plant on which *Plesispa reichei* has been found is *Ortheodoxa regia.*

Beetle.

Before the beetles emerge from the pupae the wing sheaths appear greyish in colour but on their emergence the elytra are creamy white. The deceptive colouration of the adult in the pupa is due to the wings

which are smoky showing through the transparent wing covers. The elytra soon require the characteristic shiny black colour.

The beetles can fly and have been frequently noticed on the wing. They endeavour to shun light and will crawl to any convenient dark place.

Large numbers of beetles have been collected from time to time from the field and examined in order to find out the number of females as compared with males. The number of females is slightly in excess of male beetles, for instance in the last consignment of beetles received from the West coast of Malaya there were 101 males and 126 females.

The time elapsing before the newly emerged female deposited her first egg varied from 28 to 58 days.

Females after the first act of copulation took from 7 to 10 days to produce eggs.

Out of a total of 313 eggs, 185 hatched on the seventh day, 110 on the eighth day, 17 on the ninth day, and 1 on the tenth day giving an average of 7.16 days for the incubation of the egg.

The maximum length of time found for the life of the female was 287 days and for the male 273.

Adults deprived of food died in from 3 to 5 days.

Observations on the deposition of eggs showed that on two hundred occasions females laid eggs at an interval of one day, on two hundred and twenty-two at an interval of two, ninety four at an interval of three, thirty-five at an interval of four, twenty-one at an interval of five, six at an interval of six, five at an interval of seven, four at an interval of eight, one at an interval of nine, two at an interval of ten, two at an interval of thirteen, two at an interval of eighteen, and one at an interval of twenty-one days. On five hundred and sixty four occasions one egg was deposited and on thirty-three two eggs

The largest number of eggs laid by an individual female was 112 in 219 days.

Larva.

There is little change in the colour of the larva during its growth. After moulting its colour is creamy white with indications of black eyes and brownish mandibles. Later the characteristic yellowish colour is acquired.

The larva passes through four instars. The larval skin is, however, not discarded on pupation but remains attached to the anal segment.

Results obtained from the records on the Moults of thirty grubs of *Plesispa reichei*, show that the average duration of the instars in days of the first is 6.2, of the second 6.4, of the third 7.1, and of the fourth 13.4, making the total in days 33.1, for the larval stage.

Pupa.

The pupa is always situated with its ventral surface to the leaf. If turned on its dorsal surface it regains its former position.

The pupa is capable of movement. Out of one hundred and seventy-two pupae placed with their heads away from the light, 110 remained in that position. Of the sixty-two which moved, 18 rested at about right angles to the light and 16 turned to the light whilst 28 remained with their heads away from the light.

The pupal stage lasts from 6-11 days; out of 100 pupae, in 3 cases the pupal stage lasted six days, in 65 cases seven days, in 25 cases eight days, in 4 cases nine days, in 2 cases ten days, and in 1 case eleven days.

The Summary of the Life Cycle.

	Minimum number of days.	Maximum number of days.	Average. number of days.
Egg	7	10	7.46
Larva	30	38	33.10
Pupa	6	11	7.40
	43	59	47.96

Under natural conditions twenty newly hatched larvae placed on five seedling palms reached the adult stage in the following number of days 38, 43, 41, 38, 37, 40, 40, 38, 36, 3[illegible], 38, 41, 42, 3[illegible], 37, 39, 41, 40, 43, 47, these figures give an average of 39.7 days which is similar to the average number of days (40.5) for the larva to reach adult condition in the above "Summary of the Life Cycle."

A Chalcid egg parasite has been recently found and preliminary observations indicate the eggs of *Plesispa reichei* are not highly parasitised and breeding work shows that the time elapsing between the parasite laying an egg in the egg of *Plesispa reichei* and emergence of the adult may be 8 days.

Preventive and Remedial Measures

Plesispa reichei is essentially a pest of seedlings in the nursery and young palms in the field, and if the palms are growing under healthy conditions, little permanent injury is caused owing to the plant continually increasing its leaf surface.

In nurseries planted under coconut palms, grubs and adults are usually found retarding the growth of the seedlings, and it is particularly important that nurseries should be made either in an empty space with shade or under trees other than coconuts

On an Estate where *Plesispa reichei* was present in large numbers, seedlings of two months planted under coconut trees showed the presence of beetles whilst under rubber trees not far removed seedlings of six months were free from beetles.

In planting or supplying seedlings from the nurseries to the field, the young palms should be freed from the presence of eggs, larvae, pupae, and adults of *Plesispa reichei* by collecting or immersing the whole seedlings in Lead Arsenate at the rate of 4 lbs. to 100 gallons of water.

This Lead Arsenate solution is readily made. The amount of the Lead Arsenate is made up at first into a thin paste in a suitable vessel and then diluted with the requisite quantity of water.

Immersion will wash off a number of the different stages of *Plesispa reichei* and the poison on the plant will kill the remainder. If the plants have been subjected to heavy rain after the first immersion, it may be necessary to immerse them again before planting out or if planted out, to spray them so as to kill the young larvae which have hatched from eggs since the first immersion.

When the insects are present on young palms in the field an application of the solution of Lead Arsenate by spraying well into the centre of the palms once every three weeks will probably be found cheaper and more effective than hand collection.

Received for publication March 20th, 1923.

THE COMPOSITION OF KEDAH AND PERLIS PHOSPHATES.

By V. R. Greenstreet.

During the last two years a number of samples of Kedah and Perlis phosphates have been analysed with a view to determining their value as fertilisers,

Description of Samples:—All the samples were decidedly heterogeneous and their colour ranged from light brown to chocolate. They contained many large particles and the samples for analysis were all well mixed and powdered.

The following table gives the results of the analyses:

Numbers 1, 2, and 3 were from Gunong Keriang, Kedah.

" 4, 5. and 6 were from Bukit Keplu, Kedah.

" 7 and 8 were Perlis.

" 9 and 10 were purchased in Penang and were probably Perlis phosphates.

		1	2	3	4	5	6	7	8	9	10
Moisture	%	3.1	2.6	9 0	3.4	2.3	3.8	.51	—	—	4.6
Loss on ignition	,,	13.8	16.3	10.9	9.3	7 9	11.6	17.6	—	11.7	—
Acid Insoluble	,,	20.0	16.8	26.0	43 8	47.0	51 0	17.8	12.0	40 5	—
Phosphoric Acid (P_2O_5)	,,	21.4	31.4	16.7	18 5	20.5	11.5	10,8	18.7	12.0	6.8
Total Nitrogen	,,	0.32	0.67	1,5	0.36	0.55	0.74	0.34	traces	0 16	0 50
Albuminoid Nitrogen	,,	0 23	0.60	1.12	0.24	0.44	0 63	—	nil	—	—
Ferric Oxide & Alumina ($Fe_2O_3 + Al_2O_3$)	,,	32 0	32.6	33.6	22.8	21 6	19.5	9.6	43.3	26.5	—
Lime (CaO)	,,	9.7	0.26	3.85	2.18	0 70	2.60	25.6	traces	nil	nil

Remarks and Conclusions:—Sample No. 7 was particularly heterogeneous. It contained two definite constituents (a) pale yellow crystals (b) chocolate coloured and amorphous. Upon ignition the crystalline constituent became pure white. It was found to consist chiefly of calcium hydroxide with a small proportion of calcium phosphate. After exposure to the atmosphere for a few months it combined with carbon dioxide from the air to form calcium carbonate. The amorphous constituent upon ignition became pale pink. It contained all the nitrogen and no calcium: the aluminium and a little iron was found to be combined with the phosphoric acid. The "available" phosphoric acid (soluble in 1 per cent citric acid) amounted to 5 per cent on the mixed sample. This "availability" may be attributed to the mass action of the large excess of soluble calcium hydroxide over the proportion of aluminium and iron.

The other samples of Perlis phosphate contained no calcium and although two of them contained a higher percentage phosphoric acid than No. 7 this was combined with aluminium and iron in a form which is considered to be unavailable.

The Kedah phosphates contained more phosphoric acid than the Perlis phosphates but in every case the aluminium and iron were so largely in excess of the lime that the mass effect of the latter in rendering the phosphoric acid "available', would be negligible.

As nitrogen fertilisers these phosphates have a small value and in this respect the Kedah phosphates show superiority.

Pot-culture experiments with one sample of Perlis phosphate (Sample No. 7) have shown it to be inferior to Christmas Island phosphate in which the phosphoric acid is exclusively combined with lime. Large scale fertiliser experiments on padi are in progress.

Summary :—Kedah and Perlis phosphates show great variation even amongst themselves and are very heterogeneous products. The phosphoric acid in Kedah phosphate varies from 12 per cent to 31 per cent and in Perlis phosphate from 7 per cent to 19 per cent. It exists in combination with aluminium and iron largely in the form of of Wavellite (hydrated aluminium phosphate). One sample of Perlis phosphate examined contained a large excess of lime which rendered the phosphoric acid "available." In every other sample the aluminium and iron predominated.

THE

Malayan Agricultural Journal.

Vol. XI. April, 1923. No. 4.

EDITORIAL NOTES.

LIME FRUIT PRODUCTS.

Attention is drawn to the fact that a Fruit Growing Syndicate in the Lower Perak District, on whose estate the cultivation of limes has been taken up on a commercial scale, has recently despatched trade samples of its products to London for sale.

The following products were included in the shipment:—

Concentrated Lime Juice.

Hand-pressed oil of Limes.

Distilled oil of Limes.

There is every reason to expect that these trade samples will command a good price on the London market, though whether this country will be able to compete in the European market with Italy and the West Indies is still a matter for conjecture.

At present, consequent upon the depreciation of the lire, even the West Indies are finding it difficult to compete with Italy and it is understood that suggestions have been made for a preferential tariff in favour of West Indian Products landed in England.

5th March 1923.

FRUIT GROWING IN MALAYA.

Fruit Orchards in Malaya at present are few and far between yet small holders by taking up the matter seriously could obtain substantial profits by planting fruit trees and supplying the local market with fruits such as oranges, chikus, limes, etc.

These fruits will grow and market well in this country as has been proved by several men who are making good profits from small orchards.

A small holder in the Lower Perak District has a flourishing little Chiku and Orange orchard of ¼ acre extent. Propagation is carried on by marcottage—a process which all Malays know. Trees planted in this manner bear fruit in 16—18 months. The local market absorbs all the crops and a good business is done by selling marcotted plants at $1.10 per plant. So successful has the owner been that he is opening up new land to extend his fruit cultivation. Inquirers who are interested can obtain the name of the owner by applying to the Secretary for Agriculture and quoting the No. C.A.I. 297/22.

An enterprising Estate Manager near Batu Gajah has planted up a 20 acre orchard of fruit trees imported from Australia. The land is openly situated on gently undulating slopes facing West, North and East, and is contour-terraced to prevent wash. The soil in a fine loam containing laterite. The varieties planted are:—Washington Naval Oranges, Geneo Lemons, Villa Franca, Tahite Limes, Seedless Pomelos, Scarlet Mandarin, Cunquat, Mandarins 4 varieties (Emperor, Beauty of Glen, Tangarine, Retreat) Bengal Citron, Early Sillitta Oranges; they are all growing well and are aged from one to three years.

23rd April 1923.

THE CULTIVATION OF ORANGES (CITRUS AURANTIUM) IN THE MALAY PENINSULA.

By F. G. Spring.

It is generally considered that the Malay Peninsula is not suitable for the growing of oranges. The orange is frequently cultivated particularly by Chinese, but the varieties are not of good quality; they are of the green type which do not turn yellow and are, as a rule, too acid for dessert purposes being more suitable for the making of cooling drinks. Fruit culture until quite recently has received little or no attention as regards propagation, tillage, manuring, pruning, pests and diseases; and it is too much to expect that any crop will improve under neglected conditions. A few residents however have taken a keen interest in the cultivation of fruit trees and special mention might be made of Mr. Tan Chye Siam of 60-2 Jervois Road, Singapore, as having had great success in the growing of oranges. The writer visited his orchard recently, and was much impressed with the results obtained. Seven years ago Mr. Tan Chye Siam commenced propagating the trees by marcottage from oranges grown in Singapore. The parent trees are of the ordinary type grown in this country but precaution was taken to select the best yielders and healthiest trees for marcotting purposes. The improvement of the stock is due to a number of factors. The mother plants were well cared for and the land maintained in a good state of tilth. Lalang and other noxious weeds were eradicated and the ground tilled periodically. The trees, therefore, were more suitable for propagation purposes than those growing under neglected conditions. The marcotted plants come into bearing in about three years; this is a very much shorter period than that taken by seedlings to produce fruit; soil conditions however appear to have considerable influence. The oranges now obtained are very different to those of the original stock. They are of the yellow type and, in size, are about equal to that of the best imported varieties. The flavour is good, although perhaps not up to the standard of first class oranges but considering the progress made in so short a time it is not improbable that ultimately the flavour will compare favourably with fruits grown in other countries. The oranges are very juicy and contain a small number of seeds. The plants are at present yielding an average of 200 catties of oranges per tree. There is a ready market for them and it is to be hoped that the industry may develop to such an extent as to render the importation of oranges unnecessary. The writer does not wish to be too optimistic as to the future of the crop but the results obtained in this orchard in Singapore are sufficiently promising to warrant the cultivation on a larger scale.

Marcotted plants, in limited numbers, can be obtained from Mr. Tan Chye Siam at a cost of $1/- each, exclusive of packing charges and freight.

A few general remarks on the cultivation of the orange may be of assistance to prospective growers.

As regards climate, the best results would no doubt be obtained on the hills. On the plains, the drier parts of the Peninsula are recommended. Heavy rains are detrimental to both the fruit, and the tree. The orchard requires to be sheltered from strong winds. The soil should be rich in plant food and frequent failure is due to unsuitable soil conditions. Trees grown under poor soil conditions are weakly and are subject to insect attacks and fungus diseases. The chief requirements of the orange tree are said to be lime and potash. In good soils, the trees may be planted at distances of fifteen or sixteen feet apart each way, the distance being slightly reduced in poor soils. Planting may be done during the wet season. The land requires to be dug over at least once a year, and frequent light tillage around the trees is recommended. The area should be kept free from lalang and other noxious weeds and every means taken to prevent surface wash. Green manuring is beneficial but the green matter must be incorporated in the soil periodically, at least round the trees, as tillage is essential.

Trees which are not thriving may be greatly improved by digging a trench around them and filling with a liberal supply of manure and good rich soil. The soil and manure must be well mixed previous to application. The circumference of the trench will, of course, depend on the size of the trees but a radius of 4 feet is regarded as a minimum distance. A top dressing of manure every year is greatly beneficial although, on first class land, manure may be applied at longer intervals. The manure is slightly turned under the surface, a matter of a few inches. Organic manure such as cattle, sheep, pig, night soil, leaves, etc. may be used—a sprinkling of wood ashes, lime and bone manure is of great benefit.

Oranges require little pruning except as regards the removal of superfluous, dead and broken branches.

A few growers, here, propagate the tree by marcottage and this is recommended. Budding and grafting are common methods of reproduction. Plants raised from seed are liable to produce fruits of a variable character.

The officers of the Department of Agriculture will be pleased to give growers every assistance.

Received for publication April 9th, 1923.

SPRAYING FOR CITRUS SCAB.

By A. Thompson.

In view of recent attempts to establish lime cultivation on a commercial basis in Malaya the spraying experiments described below should be of interest.

Lime trees (*Citrus medica*, var. *acida*) are frequently attacked by a disease known as "Citrus Scab" which attacks the leaves and fruits. On the leaves it produces corky elevations on the upper surface, accompanied by corresponding depressions on the lower surface, and often so distorts and injures the leaves that they are prevented from functioning properly. The fruits when attacked become roughened and scabby and their market value is greatly reduced. Young nursery stock may become very stunted if attacked by scab and rendered useless for budding. The disease has been attributed to a fungus *Cladosporium citri* and occurs on lemon (*C. limonum*) Pomelo, shaddock (*C. decumana*), mandarin (*C. nobilis*), and other citrus fruits on which it causes scab of varying degree of severity.

The following is an abstract from a recent report on control o Citrus Scab in Porto Rico.*

"Citrus Scab is the worst pest that the grower of citrus fruit has to contend with in Porto Rico. This disease, during the first years of the citrus industry, only attacked young trees, the old being immune. During the past few years this does not hold and many old trees that once bore fine fruit are now producing crops, practically worthless for shipping, that must be sold for canning purposes.

A co-operative spraying experiment for Citrus Scab was started with one of our largest growers. The results of the first season's work is very encouraging. The season was exceptionally wet and the bloom extended over a prolonged period.

Four applications of Bordeaux oil were made to 3,000 trees which were being prepared for early fruit *i.e.* blossomings in December, January and February. The blossomings are not often heavy and as they come during our cold winter rains the fruit is liable to be very scabby. The first spray was applied on December 29th. The second on January 27th, the third on February 13th and the fourth on March 9th. Just prior to January 27th a second blossom appeared which set well. Following the February and March sprayings there was a flush and a blossom. The fruit which appeared after the last spraying with Bordeaux, was sprayed with lime and sulphur on March 25th. By this time the rust mites had made their appearance.

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* Agric Extension Notes. Porto Rico Agri. Expt. Station.
W. V. Tower, Jan. 1923.

The results in the six groves of 3,000 trees are as follows :—

	Per cent.
Clean fruit	94.4
Just a trace of scab	5.2
Slightly spotted with scabby areas ...	.4

Check trees (unsprayed) were selected in one of the worst infected groves on this property. These are at the foot of a cliff and do not get the early morning sun. The scab infection in these trees was as follows :—

	Per cent.
Clean fruit	10
Just a trace of scab	44.7
Slightly spotted with scabby areas ...	27.5
Very badly scabbed but not knotted ...	17.5
Knotted and covered with scab	0.3

Sprayed trees in the same grove showed the following :—

	Per cent.
Clean fruit	90.6
Just a trace of scab	9.3
Slightly spotted with scabby areas ...	0.1

Another grove on the same property was divided into three sections. One part was sprayed four times another part two times (Sic) and the remainder not sprayed. The results were as follows :—

	Sprayed four times. Per cent.	Sprayed two times (Sic) Per cent.	Not Sprayed Per cent.
Clean fruit	91.2	83.9	24.5
Just a trace of scab	8.8	15.0	37.5
Slightly spotted with scabby areas ...	—	0.6	24.5
Very badly scabbed but not knotted	—	0.5	13.0
Knotted and literally covered with scab	—	—	0.5

A grove of 900 trees was sprayed on January 13th with Bordeaux 3-4-50 and ½% oil and again with the same formula on April 12th. These two applications were made before the spring blossom which occurred in May. The blossom was very heavy on May 11th and the grove was sprayed with lime-sulphur 1-30. The results were as follows :—

	Per cent.
Clean fruit	97.3
Just a trace of scab	2.4
Slightly spotted with scabby areas ...	0.3

Another grove of 800 trees which also blossomed late was treated as follows:—Sprayed April 5th with Bordeaux 3-4-50 and ½% oil and again on May 8th with same formula. The blossom commenced to come out on April 29th and on May 9th was heavy. The results showed:—

	Per cent.
Clean fruit	93.8
Just a trace of scab	6.0
Slightly spotted with scabby areas ...	0.2

The results obtained are very encouraging, but Bordeaux oil spray for scab must not be used unless the planter is willing to fight the scale which will surely follow, for all beneficial fungi, moss or lichen are killed.

This spray if applied haphazard will give poor results. Only the best spray materials should be used. A well planned campaign should be made and carried out. Be on the constant look out for scale and rust mites as these two pests come in very quickly after spraying with Bordeaux Oil. Plenty of material for fighting them should be on hand.

Recent tests with the Oil emulsion have been made at the station on grape fruit trees with fruits six months old. The solution has been used at the following strengths 1, 1-1½, 2-2½, and 3 per cent. of oil emulsion. There has been no dropping of leaves or burning of leaves or fruit.

In all the tests made with Bordeaux oil, using 3-4-50 Bordeaux with ½% oil there was a little burning of the young tender shoots. No small fruits or open blossoms were injured by this strength of spray. A few unopened blossom buds were burnt and dropped but no serious loss of leaves or blossoms was apparent.

If lime growers in Malaya ever embark on lime growing on an extensive scale there is every possibility of scab causing considerable trouble, but the success of the control measures recorded above is encouraging to those interested in this culture.

An account of the procedure to be adopted in making Bordeaux mixture is to be found in the *Agricultural Bulletin F.M.S., Vol. 1*, No. 11, 1913. To this mixture a good oil emulsion is added to make Bordeaux oil.

Spraying as above will assist in combating not only Scab, but also the other diseases of lime trees which are often serious, and which respond to Bordeaux treatment.

Received for publication March 26th, 1923.

SUMMARY OF OBSERVATION ON *Rhynchophorus schach*, OLIV.

THE "RED STRIPE" WEEVIL OF COCONUTS.

BY G. H. CORBETT AND D. PONNIAH.

GENERAL information concerning this insect in Malaya under the name of *Rhynchophorus schach*, Oliv. or *Rhynchophorus ferrugineus*, var. *schach*, Oliv. or "Red" weevil is available, but little detailed work has been published.

A study of this insect was commenced in 1920, and the principal observations made since that time are recorded in this "Summary of observations on *Rhynchophorus schach*." The details of the experiments will be published later in a Special Bulletin of the Department of Agriculture.

Rhynchophorus ferrugineus, Oliv. and *Rhynchophorus ferrugineus, var. schach*. Oliv.

Rhynchophorus ferrugineus, Oliv. is a reddish coloured weevil usually possessing black spots on its pronotum, but the insect found in Malaya is black with a red stripe on the pronotum. Dr. Guy A. K. Marshall has suggested that it would be wiser to treat the two forms as distinct species (viz :--*Rhynchophorus ferrugineus*, Oliv. and *Rhynchophorus schach*, Oliv.) until their specific identity has been definitely proved.

The two insects are so distinct in colouration that in future entomological writings in Malaya, *Rhynchophorus schach*, Oliv. will be referred to as the "Red Stripe" weevil and not as the "Red" weevil.

A number of variations of *Rhynchophorus schach* occurs in Malaya. The most commonly found variety has similar prothoracic characters to *Rhynchophorus schach*, but the elytra instead of being entirely black have reddish and black longitudinal markings.

Rhynchophorus schach is only found in Malaya, Sumatra and Borneo, *Rhynchophorus schach* and *Rhynchophorus ferrugineus* are both represented in Celebes, Java, and the Philippines, whilst in India, *Rhynchophorus ferrugineus* only occurs.

NATURE AND INDICATIONS OF DAMAGE TO COCONUT PALMS.

This insect is injurious to coconut palms only in the larval stage. Soon after hatching the larva commences its operations and by gnawing and boring its way through the tissues may reach the very heart of the cabbage. The work is so rapid and the effect so deadly,

that these grubs are very much more dangerous to the life of the tree than is any other coconut insect.

In crown infection old and young trees are characterised by the falling down of the central shoots. Trees have been observed, in which the attacks of the "red stripe" weevil, as indicated by the presence of cocoons, have set up suitable conditions for the "black" beetle (*Oryctes rhinoceros*) to lay its eggs, although the old leaves were still greenish in colour.

In trunk infection there is frequently associated with the unhealthiness of the palm an exudation of a gummy nature, while at the same time discarded fibre often projects from the holes in the stem.

An attacked tree is occasionally detected by placing the ear against it when the gnawing of the grubs, if in sufficiently large numbers, may be heard.

The number of grubs in a tree varies considerably but it would appear that the female weevil having once found a suitable place for deposition does not go to many other suitable grounds farther removed. In the top of a "rembia" palm as many as 150 larvae have been counted, and in a coconut palm 76 cocoons have been noted. It should be mentioned, however, that probably more than one weevil was attracted for egg laying.

Relation between the "Red Stripe" Weevil and the "Rhinoceros" or "Black" Beetle. (Oryctes rhinoceros, Linn.)

Rhynchophorus schach occasionally takes advantage of the borings into the crowns of coconut palms made by *Oryctes rhinoceros*, Linn. for egg laying. It is not implied that all, or by any means nearly all, coconut palms attacked by "black" beetles are visited by *Rhynchophorus schach*, but when the crowns are injured by the "black" beetle, conditions attractive to the "red stripe" weevil are set up.

The chief reasons why coconut trees damaged by *Oryctes rhinoceros* are often not attacked by *Rhynchophorus schach* are :—

(1) The absence of the "red stripe" weevil in the district. On the sides of new clearings where conditions are frequently suitable for the breeding of both beetles. because sufficient precautions have not been taken while burning off the jungle to destroy completely all sago, "serdang", "nibong", and other palms, young coconut palms frequently show signs of attack by the "black" beetle, yet no loss has been occasioned by the "red stripe" weevil. Indications that coconut palms have been attacked by the "black" beetle may be seen daily, but the "red stripe" weevil has not followed.

(2) The presence of other suitable breeding material. There is no doubt that the "red stripe" weevil prefers other injured palms to coconut and in a district where there is an accumulation of material

of some other palm, e.g. sago, attacks on coconut trees by this insect are not so numerous.

(3) The individuals of *Oryctes rhinoceros* are more numerous than those of *Rhynchophorus schach* and therefore probably more trees are liable to be damaged by the former than the latter.

Enormous damage can be done by the adults of the "black" beetle and by the grubs of the "red stripe" weevil, but the former insect rarely kills the trees. Damage by the latter is often fatal especially as the damaged palm frequently attracts other weevils for egg-laying. One grub of the "red stripe" weevil may cause the death of a palm if it damages the bud; in fact, in an experiment where the grub had bored through the base of the bud, the bud was killed primarily on account of this injury.

Relation between Fungus and Bacterial Diseases of Palms and *Rhynchophorus schach*, Oliv.

Weevils coming from a diseased tree may be carriers of fungus or bacterial diseases to palms only if the conditions there are suitable for egg-laying, e.g. after injury to palms caused by the "black" beetle, and the grubs may provide a means of entry for diseases.

Since, as will be shown later, weevils are not considered to visit undamaged trees, there seems little danger of their acting as carriers of infection from diseased trees.

Host Plants of *Rhynchophorus schach*, Oliv.

Besides the coconut palm (*Cocos nucifera*), the following palms have been found suitable for the development of this insect:—

Sago (*Metroxylon sagu*); Sugar or Kabong (*Arenga saccharifera*); African oil (*Elaeis guineensis*); Serdang (*Livistonia cochinchinensis*); Nibong (*Oncosperma tigillaria*); Areca or Betel nut (*Areca catechu*); Royal (*Oreodoxa regia*); Gebong (*Corypha genbuga*); and Bagas (*Oncosperma horrida*).

In India, *Rhynchophorus ferrugineus* has been reported from the Date Palm (*Phoenix sylvestris*) and Palmyra or Toddy palms (*Boraseus flabellifer*).

General Life History.

The eggs, which may be laid in any damaged portion of a palm, hatch in about 3 days to whitish legless wrinkled grubs. The larvae feed inside on the tissue of the palm and when full grown make cocoons of fibres. Inside the cocoons they change to pupae from which adults emerge.

(1) Egg. Method of Egg-laying.

The method of egg laying was observed on a number of occasions. The female weevil at first tries by means of its antennae and rostrum to find a suitable place for the deposition of the egg. Having found a convenient spot, she bores a hole in the wood with her snout. This action is aided by a backwards and forwards rocking movement. The snout is inserted usually as far as the base of the antennae but occasionally as far as the funiculus. The hole is made slightly larger in diameter than the breadth of the egg, and frequently the rostrum is withdrawn and inserted again so as to increase the size of the hole. The hole is straight at its commencement but the base is slightly curved so that in shape it is similar to the snout of the female. The female having completed the hole to her satisfaction, in the majority of cases observed, turns round and after finding the hole with her ovipositor deposits an egg. Only very occasionally is the hole not found and too small to receive the egg. If the egg is deposited on the surface or partially exposed above the opening, the female breaks the egg and completely consumes its contents together with the egg shell. The egg inside the hole has never been found damaged.

The hole is always cemented after egg laying by a pinkish substance having a definite structure. Examined under a lens the plug is cup-like in shape with a dividing piece—broader at one end than the other -across the centre, and placed with the concavity towards the surface of the hole. Two small holes in the blunt end may be followed through the plug and appear enlarged on each side of the partition. This plug is placed 1 millimetre above the egg and is probably a protection against egg parasites, but on account of the difficulty of finding the egg in nature no definite information on this point has been obtained. Eggs laid in breeding cages were deposited at any angle. At the end of the wood they were usually parallel to the fibres; in the wood, parallel, oblique, or perpendicular.

The broader end of the egg is always situated at the base of the hole previously made by the female weevil. The hole varies from 3 to 8 millimetres in depth, but is usually about 5 millimetres.

Egg laying takes place as much by day as by night. In an experiment 101 eggs were laid between the hours of 6 a.m. and 6 p.m. and 128 between 6 p.m. and 6 a.m. This is remarkable as, judging by the hours during which weevils were attracted to traps, they are not active fliers by night. The weevils noticed in the field at night are decidedly inactive and when thrown in the air make no attempt to fly, in fact they usually try to bury themselves in the grass or to find any convenient dark place. Weevils found on trees at night are closely 'adhering' to the trunk and at least, on the African oil palm, appear to prefer places of concealment.

Places of Egg Deposition.

Considerable doubt exists concerning the places where eggs are deposited by the "red stripe" weevil in coconut palms, and a most debatable subject has been the capability or otherwise of this weevil

to lay its eggs in sound trees. Since there is discrepancy amongst accounts, experiments were commenced to ascertain, in the first place, if adults could lay eggs in sound trees.

The result of these experiments showed that weevils were unable to lay their eggs in the crowns or at the bases of leaf petioles of coconut palms unless previously damaged.

Further experiments showed that weevils were unable to lay their eggs in the unbroken stems of coconut palms, but could deposit them in wounded stems.

Series of experiments were undertaken to find out if larvae, after being placed in holes at different heights in palms of various ages, could penetrate the tissue of the palm. These series represented eightyone occasions when eggs or grubs were placed in separate holes to a depth of 1 to $1\frac{1}{2}$ inches at different positions of the trunks in palms varying in age from 3 to 14 years of age. Only on two occasions after examination at the base of a palm 10 years of age were live grubs found. No penetration towards the centre of the palm was, however, noticed. The grubs were working on the soft portion of the rind which was rather wide at the base in this particular tree.

The results from these experiments are entirely different from those expected. The hard freshly exposed cylinder of vascular bundles immediately below the rind, being compact and dry, seems to act as a barrier to the successful ingress and feeding of the larva. The rind varies in thickness from one tree to another and is narrower at the top than at the base. In a number of cases, eggs and grubs were placed in the hard freshly exposed area of vascular bundles and the young larvae, from the eggs and those introduced, not being in close proximity with succulent food material, were unable to live.

The result of an experiment conducted by placing one day old grubs near the base and in the centre of a palm about 25 years of age indicated that if the interior of coconut palms up to 25 years of age is exposed the tissue provides suitable material for the development of the grubs.

From the results of these experiments, grubs of the "red stripe" weevil entering the palm through toddy steps should not occur so long as the steps are not cut more than 1" deep or through the compact tissue. This should be kept in mind when making cuts near the crown of the tree, but since toddy steps are not necessarily required in such positions there is little need for this warning.

Further experiments were conducted to find out the advisability of cutting or pulling the leaves off coconut trees by placing one-day old grubs in the cut ends of petioles at various distances from the trunk. The tissue of the leaf petiole was found to provide suitable food material in so far that grubs successfully reached the adult stage in this material and a grub penetrated the trunk of a palm after having previously eaten through 36 inches of petiole tissue.

In conjunction with the success obtained from these experiments it should be mentioned that cocoons and feeding galleries of the grubs of the "red stripe" weevil are frequently found on leaf bases and that a female was observed in nature to lay an egg in the cut end of a petiole of an African oil palm, so that pulling or cutting the leaves of coconut palms should not be practised.

(2) The Larva.

The larva or grub causes the damage to coconut trees. When the eggs hatch out the grubs are in close proximity to their food and as they grow the feeding galleries increase in size.

Larvae about the same or of different ages may be found together in an attacked coconut palm, frequently full grown larvae, cocoons, and adults are found together and in such cases very young larvae are usually not present. This is to a certain extent explained by the fact that the palm being in a more or less rotten condition has lost its attractive power for egg laying weevils.

The larvae shun light. This was often noticed in breeding cages where larvae, having eaten down to about 1" of the bases of logs of palm wood, turned and tunnelled in an upward direction.

The larvae prefer moist and young succulent palm wood, and some species of palms to others. The following palms are considered in order of decreasing suitability for the development of the larva. Sago (*Metroxylon sagu*); Nibong (*Oncosperma tigillaria*), Coconut (*Cocos nucifera*), African oil (*Elaeis guineensis*). Sugar or Kabong (*Arenga saccharifera*); and Areca or Betel (*Areca catechu*).

The grub does not feed on the longitudinal fibres. The fibres, having been cut through and the soft succulent tissue eaten, are collected and passed by peristaltic movements beneath the grub's body to the rear of the tunnel.

The greatest distance tunnelled by a larva through a nibong palm was 6 feet 8 inches in 56 days

Grubs submerged in water for three days died.

Moulting.

Prior to moulting grubs do not feed. This indicated a cast skin would probably be found on the following day. In each moulting operation observed, the skin split along the dorsal line generally as far as the third segment and the grub came through the rupture by gradually working the old larval skin backwards. The newly emerged larva including the head and first thoracic segment is creamy white in colour with the exception of the darkish coloured mandibles. In about an hour the general colour of the larva is assumed.

The minimum number of moults found for the larva was 16 and the maximum 20.

(3) Pupa.

After making its cocoon the larva is quiescent. Gradual shrinking takes place and a few days prior to pupation the larva assumes a distinct inactive larval form. In this stage, the ventral surface is very much flattened and the segments are more pronounced. When disturbed the prepupa does not crawl but wriggles—a habit usually associated with the pupa. After this stage, there are definite pupal and inactive weevil stages in the cocoon.

In order to find out the length of time occupied by the various stages in the cocoon, a number of full grown grubs was collected and the dates on which the cocoons were completed were noticed. The cocoons were slightly cut in the middle so as to observe the changes, secured to prevent weevils emerging through the openings, and kept on damp chips of palm wood.

The following results were obtained by observing the changes in the cocoons treated in the above manner:—

From 2 to 4 days were passed before the larva assumed the inactive form, the inactive larval stage occupied 3 to 7 days, the pupal stage from 11 to 15 days, and the inactive weevil stage from 10 to 15 days, making the time passed in the cocoon vary from 26 to 41 days.

(4) Weevil.

Weevils require food: when deprived of food they died in from 3 to 7 days. The maximum length of life found for the female was 116 days and for the male 107 days. The maximum number of eggs laid during the life of a female was 832, by an individual in one day was 35 but the average daily number of eggs was 7.7.

The weevils are very strong fliers and have been recorded flying 900 metres. The distance travelled has an important bearing on the destruction of breeding places not far removed from coconut plantations: the sanitation of such places as "rembia" clumps for the control of this insect is essential.

Trapping.

Coconut and other palm wood attracts "red stripe" weevil and in order to obtain definite information, concerning the advisability of recommending the employment of traps, experiments with several species of palm, split and cut into suitable lengths—about 1 metre—were conducted.

The number of weevils caught by the employment of traps composed of different species of palm was far smaller than was expected. The variation in the trapping experiments conducted at Tampin, and at Kuala Lumpur, might be explained by one site possessing less attraction than the other, owing to the proximity of suitable breeding material near the less successful site.

The traps were composed of the following palms; nibong, areca, coconut, sugar, and sago. In traps composed of sugar and coconut palms, no weevils were collected, though, under natural conditions, the larvae of this weevil have frequently been found in these palms. To some of the traps consisting of areca, nibong, and sago palms, weevils were attracted,

From the results of the experiments and from general observations both nibong and sago palms are considered to possess greater powers of attraction than either coconut, sugar, or areca palms.

When Sago palm traps had a fresh surface exposed every day the attraction seemed to be greater.

Weevils were attracted on the second day and continued to be until the sixteenth day after the surface of the palm was exposed.

The weevils commenced flying after six in the morning and continued throughout the day. They appeared to be more active between the hours of 6 and 9 than at any other time, gradually decreasing in their activity towards evening.

Forty-four females and thirty-four males were caught at the traps showing that the sexes were attracted in about equal proporitions.

CONCLUSION.

Trapping "red stripe" weevils cannot be recommended as a general practice, though, if coconut trees are frequently killed by this insect and if nibong or especially sago palms are easily obtained, a system of trapping may be of considerable value in reducing the numbers in the area. The traps should be visited frequently during the day time and the weevils collected and destroyed.

WEEVILS VISITING HEALTHY PALMS.

In discussing the "Relation between Fungus and Bacterial Diseases of Palms and *Rhynchophorus schach*, Oliv" the statement that there seems little danger of weevils acting as carriers of infection from diseased trees to undamaged trees was based on the results obtained from the Trap Experiments. Weevils were not caught at any trap either on the day or on the day following the palms being felled, and for that reason it is considered that they would not visit uninjured palms.

BURYING THE VARIOUS STAGES OF RHYNCHOPHORUS SCHACH.

Weevils buried 3 feet deep were found capable of finding their way to the surface of the soil.

Well developed grubs in palm wood buried 3 feet deep reached maturity and the weevils came to the surface of the soil.

Nibong logs containing 3-day old grubs were buried 3 feet deep and after 3 months examined. Though only two undergrown grubs were found, there is little doubt they would have reached maturity and the adults emerged through the soil.

From the results of the experiments on burying, burying coconut logs containing eggs, grubs, or adults is not recommended.

Further investigations demonstrated that weevils, although they are able to come through 3" of soil, cannot lay eggs in palm wood covered over with only 1" of sand.

The disposal of palms, though containing no eggs, by covering them over with a layer of sand is inadvisable owing to the constant supervision necessary to prevent the wood becoming again exposed, especially in Malaya where heavy storms are liable to wash the sand off the buried palms.

Life Cycle.

Considerable work has been done in order to find out the length of time taken for *Rhynchophorus schach*, Oilv. after emerging from the cocoon to complete its life cycle, and as a result of these investigations the following minimum figures have been obtained.

o Egg Stage	8 days.
x Larval Stage	59 ,,
x Cocoon Stage	25 ,,

o The majority of eggs actually hatched in just under 8 days.

x The aggregate number of days for both larval and cocoon stages found was 84 days and the shortest time for the cocoon stage 25 days making 59 days for the larval stage.

In this connection mention should be made that the prooviposition period—the time elapsing before the newly emerged weevil from the cocoon commences to lay eggs—varies from 1 to 6 days.

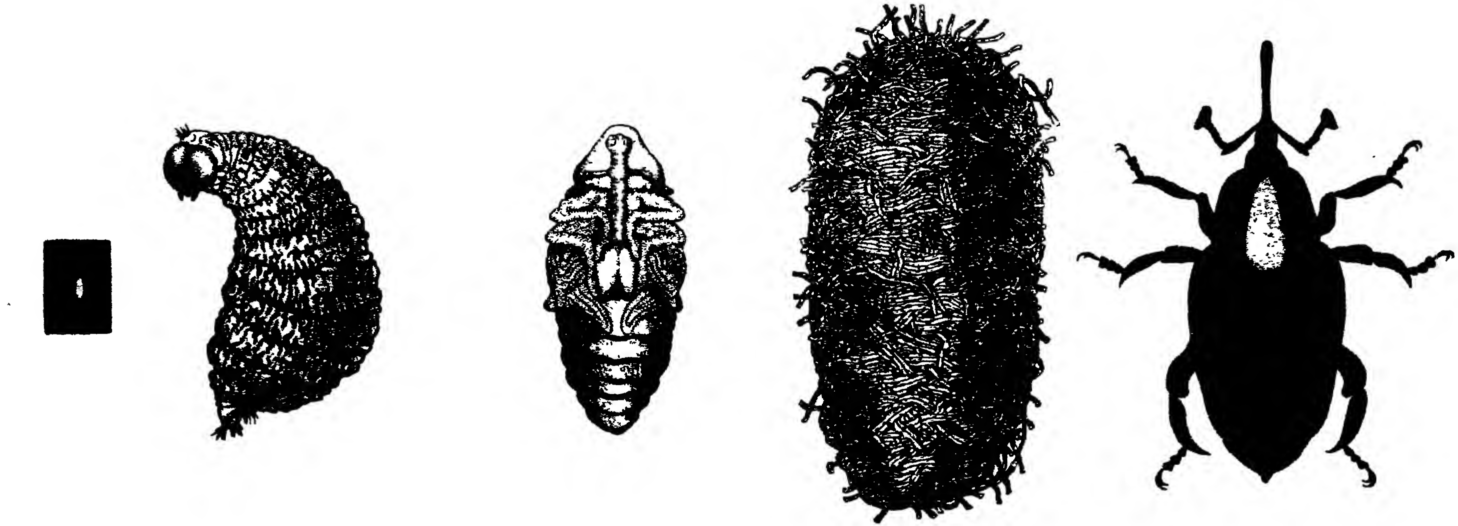
Since the "red stripe" weevil can complete its life cycle under 3 months, it is clearly essential to destroy dead palms and palm refuse before that time in order to prevent palms from acting as breeding grounds for this insect.

Control.

Though information will have been gathered concerning the control of this insect by the perusal of the previous pages in this "Summary of Observations on *Rhynchophorus schach*" the subject may be briefly considered under the headings of Precautionary and Remedial Measures.

RED STRIPE WEEVIL.

~~RED WEEVIL~~



1 2 3 4 5

1. Egg 2. Larva 3. Pupa 4. Cocoon 5. Adult

(1) Precautionary Measures.

Before the presence of the grubs of this insect becomes evident, the palm might have suffered irremediable damage, so that every precautionary endeavour should be taken.

Injury to coconut palms may be caused by (a) Insects (e.g. *Coptotermes gestroi* and *Oryctes rhinoceros*), and their control may be effective in preventing *Rhynchophorus schach*, attacking the palms. (b) Lightning and Storms. Trees which have suffered through the agencies of lightning and storms and are afterwards attacked by the "red stripe" weevil would in most cases be better destroyed, and (c), Man, by cutting steps and cutting and pulling off leaves or spikes. All wounds should be tarred at least twice, as after tarring once the surfaces are liable to become exposed again.

The prompt and thorough use of fire for the disposal of dead or decaying palms is advocated. Burying under ground is not recommended.

(3) Traps may be employed if material is available and the weevils can be regularly collected.

(4) "Red Stripe" weevils are occasionally found in the holes of *Oryctes rhinoceros* and regular collection of the latter will help in reducing the number of the former.

(11) Remedial Measures.

If the larvae destroy the growing point, which is unusual, the trees will die. The palms may escape the first attack with less than fatal injury but they will be more prone to subsequent attacks, and for sometime will be less productive. Again, weevils emerging from such attacked trees may go to other trees with the result that the attempt to save one tree may cause the destruction of several others. The wisest policy to adopt is to destroy a tree with crown infection, as soon as it is known to be infected by the "red stripe" weevil.

With trunk and root infection, a tree may sometimes be saved by removing the larvae, cutting away the diseased tissue, and disinfecting the exposed surfaces to arrest further decay. Only diseased tissue should be removed; it is unnecessary to weaken the tree by cutting away healthy wood. The cavity should be made as smooth as possible with its base sloping so as to prevent rain from lodging, disinfected thoroughly and watched for further signs of disease. The palm may be allowed to stand without further treatment but filling the cavity, especially if large, with cement might be undertaken. If the operation of cementing is performed it should be done slowly and allowance for drainage made. If the cavities are small, the resulting benefit might repay treament, but if large the cost of treating the attacked tree together with the risk that it may eventually be blown down, or that the disease may not be properly arrested from the first, would probably render unprofitable such a remedial measure.

Received for publication March 29th 1923.

REPORT ON THE WORK OF THE INSPECTION STAFF, OCTOBER 1 TO DECEMBER 31, 1922.

BY F. W. SOUTH.

I. STAFF CHANGES.

THE services of the two Special Field Officers in Negri Sembilan, engaged on the control of Mouldy Rot disease in Remban sub-district and around Rantau, were terminated on November 30th, when the work was left in the hands of the normal staff. As a result of examinations held in November certain Malay Officers received promotion at the end of the quarter.

II. DISEASES AND PESTS OF RUBBER.

Pink Disease (*Corticium salmonicolor*). This disease was newly reported on one estate in Selangor and on two in Johore. It was found for the first time in the North West corner of Penang Island, about 9 cases occurring on a small estate. No other cases in the neighbourhood were found. This is the second occasion on which Pink Disease has been reported in Penang. In other parts of the country the disease became rather more prevalent with the advent of the rainy weather; treatment was, however, steadily enforced and the situation calls for no comment.

Mouldy Rot. (*Sphaeronema fimbriatum*). This disease was newly reported on one estate in Perak North, two estates in Selangor and five in Negri Sembilan. On December 14th a report was received by the Assistant Agricultural Inspector, Perak North that mouldy rot disease had appeared in the neighbourhood of Padang Rengas, near Kuala Kangsar. Investigation showed that an estate and some 3-4,000 acres of small holdings were affected. Control measures were very promptly instituted and have been carried out satisfactorily in the main. Attempts to restrict the disease to the one area and to control it within the area are still in progress. It seems very probable that the disease was carried into Perak, where it has been previously unknown, by wandering tappers, Banjaris or Javanese.

During October the expected spread of the disease to Selangor occurred; it was discovered at Sepang where about 3 square miles of small holdings were found to have been infected for some weeks. This outbreak was probably introduced by tappers from the neighbouring mukim of Chuah in Negri Sembilan where the disease is present. The treatment of the disease was demonstrated by the Assistant Agricultural Inspector, Selangor, with the result that all but 5 small holders treated the disease satisfactorily. The few offenders were summoned and fined. The outbreak had been practically entirely overcome by the end of the year.

During November and December the disease also appeared on two estates in Ulu Langat district on the Selangor-Negri Sembilan boundary. In both cases the disease was promptly and effectively treated. No small holdings were found to be infected in this area.

In Negri Sembilan the disease has spread northward as far as the Selangor boundary at Batang Benar, but its treatment everywhere is being steadily enforced. As usual wet weather has rendered it more prevalent.

In Malacca this disease, which was found in two new areas during the third quarter, was in this last quarter found in a fourth locality, namely near Chin Chin in the Southern district not far from the Johore boundary. Energetic measures have been taken to confine the disease to the few holdings infected in this area. In the Sungei Rambai-Sebatu area the spread of the disease has been aided by wet weather and difficulty is being experienced in enforcing the proper control measures among the owners of the holdings, who are for the most part Chinese. The cessation of tapping is essential and in this lies, as usual, the main difficulty.

Wet weather has been responsible for a rapid development of the disease in Johore. The centres of infection remain the same, namely from Batu Pahat to the Muar district boundary, around Muar and Panchor, and between Batu Anam and Labis on the railway line. The swampy land in Batu Pahat and Muar districts, covered as it is with somewhat neglected rubber trees, offers conditions for the spread of a fungus such as this, which render control a matter of extreme difficulty.

Black Stripe (*Phytophthora* sp.) This disease was newly reported from one estate in Johore where it received prompt treatment. A new small area of infection was found in the Kuala Pilah district of Negri Sembilan.

Fomes lignosus. There is no doubt that certain cover crops help the spread of this fungus. The investigations of the Assistant Agricultural Inspector, Perak North, show that the method of counting stumps on young clearings showing fructifications of this fungus at one time gives no indication of the number of stumps affected, because the fruits develop irregularly on different stumps and disappear rather quickly, so that they can easily be missed; while some infected stumps may not develop fruits of the fungus for some time. However, if care is exercised the advantages of cover crops outweigh the disadvantage due to the spread of *Fomes lignosus*.

No other diseases of rubber call for special comment.

III. Coconut Diseases and Pests.

Beetles. Good progress has been made with the work of destroying the breeding grounds of the black beetle and the red stripe weevil, especially all through the Colony and in Selangor. In Johore the destruction of refuse in which the black beetle breeds is receiving

attention, though suitable decaying refuse is still very common in some parts of the State.

Nettle caterpillars (*Thosea* sp.). The caterpillars of this insect did considerable damage to 10 or 15 acres of coconuts at Sungei Batu in the Balik Pulau district of Penang. The attack is reported to have started at the beginning of September, but it was not discovered until the middle of October by which time only pupal cases of the insects could be found. The Malays on their own initiative had lighted smoke fires under the trees and had poured Brunolinum on these their aim being, apparently, to form a suffocating cloud which would cause the caterpillars to fall to the ground where they could be collected by hand, eaten by fowls, or otherwise destroyed. It is uncertain to what extent this was effective.

Brachartona catoxantha.—An outbreak of this pest occurred at the 6th mile Kuala Selangor-Bernam Road at the beginning of the quarter The outbreak was slight, and disappeared rapidly, thanks to crows and heavy rain.

Grasshoppers. (*Orthocanthacris nigricornis* and others). Some damage was done to young coconut-trees in Sepang Mukim of Selangor in November and December by semi-swarming grasshoppers, chiefly of the species named.

Plesispa reichii.—An attack of this beetle was reported on a small coconut holding in Kuantan district of Pahang.

IV. Padi Pests.

Nymphula depunctalis.—The control measures carried out at Matang have been effective and the padi there is not only free from this particular pest, but is freer from pests in general than it was last year. This may be partly due to different weather conditions, but it is also partly due to the control measures described in my last report.

Leptocorisa spp.—This pest occurred to a slight extent in various localities throughout the Federated Malay States and the Colony, but on the whole did very little damage. It is known by the Malays in Province Wellesley as "Chenanggong" and in most other parts of the Peninsula as "Pianggang."

Other pests recorded as present to a slight extent were *Nephotettix bipunctatus* ("Benah") together with an insect very near *Tettigoniella spectra* and an unidentified stem borer, in Province Wellesley; with *Podops coarctata* ("Benah Kura" or "Kutu Bruang") to a slight extent in Kuantan district and more seriously in one locality in Johore.

These pests are additional to those mentioned in my last report; on the whole, however, the padi everywhere has been singularly free of all pests other than rats.

Rats.—Before the end of the quarter the full stock of ½ ton of barium carbonate had been distributed. A further supply had been ordered by cable, but had not arrived by the end of the year. The Malays appear thoroughly to appreciate the opportunity of purchasing this poison at cost price *i.e.* one cent per oz., and it will be advisable to supply larger stocks in the coming year.

The poison seems on the whole to have worked efficiently. There was a complaint that part of the supply was not satisfactory from one district in Selangor, while in Negri Sembilan the Malays consider that barium carbonate is effective against the small rat, but not so effective against the large rat, "Tikus mondok." Reports from Malacca are variable, but success has usually followed when the baits have been properly prepared and used. Heavy rains occasionally render it useless by washing away baits. It is difficult to determine its efficiency exactly, as dead rats are not often found, they die in their holes or in water. Malays are liable to doubt the efficiency of the poison, if no dead rats are found, but, on the whole, judging by the demand, the sale of supplies at cost price has been successful.

Traps have given good results at the Experiment Station in Malacca this year and in other localities in the past and should be used to supplement the poison. It may be possible to stock traps and sell them at cost price in the coming year.

V. Lalang and Blukar.

It is hoped that the rise in the price of rubber during this quarter will induce small holders to clean up their land to some extent; if no action is taken the greater prosperity of the owners will justify the Inspecting Officers in insisting on the cleaning up of holdings in the coming year.

There is much evidence to show that giant mimosa, *Mimosa invisa*, can kill lalang. It is necessary to ascertain how long the cover must be present to eradicate the lalang completely and experiments will be started to decide this. In the meantime it is proposed to try using Giant Mimosa to destroy lalang on certain holdings in Perak North, in order to demonstrate the cost of planting it, to test its suitability on small holdings and to show its effect. The principal danger is that, if neglected on a holding with young trees, it would itself smother the rubber trees.

VI. Water Hyacinth.

In Province Wellesley useful work has been done by the Public Works Department at the request of the Assistant Agricultural Inspector in clearing the drains in the Sungei Acheh district of this post. Further work remains to be done in the coming year.

In Perak North the regular cooly gang carried out routine work in Krian district, while in Perak South during the quarter several tributaries of the Perak River were cleared of the weed and State land at Kampar was cleaned. In Selangor and Negri Sembilan a few patches found have been removed.

VII. Pests and Diseases of Other Crops.

Achatina fulica.—The Assistant Agricultural Inspector, Penang and Province Wellesley, reports that the giant snail is still to be found in small numbers, but causes little anxiety, and that he is of the opinion that it is gradually becoming extinct. This is partly due to control measures and partly to the unsuitability of the surroundings.

Collections are being made for study by the Entomologist and the Mycologist of the diseases and pests found on, and frequently common to, Roselle, cotton and silk cotton (Kabu Kabu). On Roselle and cotton pests are rather numerous.

Specimens of pests and diseases on minor crops have also been collected and forwarded for record and identification in considerable numbers, notably on citrus plants which, as in some other countries, seem very liable to insect attacks.

Giant Mimosa suffered some damage on an estate in Selangor, where it was growing as a cover crop, owing to the attack of semi-swarming grasshoppers. The attack was not serious, but efforts have been made to destroy the insects with poison.

VIII. General Agriculture.

1. *Rubber.*—With the report in October that restriction of output would be introduced the price of rubber commenced to rise. As restriction became an accomplished fact in November, the rise continued until the end of the year when the price reached 50 cents per lb. in Singapore.

As a result the Assistant Agricultural Inspector, Penang and Province Wellesley, records that a number of small holders have recommenced tapping their trees, while others appear to be adopting a more drastic system of tapping. In some parts small holders are selling their coupons instead of tapping. The prices of coupons in Selangor at the end of the year were said to be $30 to $35 per pikul coupon. Dealers are purchasing at a low price a considerable quantity of rubber not covered by coupons.

In connection with restriction the Chief Agricultural Inspector was invited in December to serve on a Committee to consider the incidence of the scale of production allowed by the rules on young estates.

Interest in bud-grafting is being maintained among planters.

2. *Coconuts.*—There is nothing calling for record, beyond the fact that the price of copra fell during the quarter to little over $9 per pikul.

Padi.—In Penang, Province Wellesley and Perak conditions have been favourable to the padi crop on the whole and in most districts a good crop is anticipated, this is especially the case in the Province where reaping had commenced at the end of the quarter. In Krian and in Larut districts the crop is late.

In Kuantan district of Pahang a better crop is expected than was reaped last year.

In Negri Sembilan the padi crop harvested in Kuala Pilah and Seremban districts was largely spoiled by the heavy rains usual at the time of year. The Assistant Agricultural Inspector, therefore, suggests that an improvement might result from a change in the planting season in such localities. The result of the harvest in Jelebu district, expected in February and March next, will form an interesting comparison with that of the earlier areas.

In Johore padi growing is as yet carried on only in a very small way. There are large areas of suitable land in the State and the Assistant Agricultural Inspector is endeavouring to give every assistance to the present cultivators in the hope of affecting improvements and stimulating padi planting. That padi can be grown successfully is shewn by the fact that an average yield of 150 gantangs per acre is obtained in Kota Tinggi district.

The testing stations at Permatang To Gelam in the Province and at Talang near Kuala Kangsar give promise of good yields. The Experiment Station in Malacca will be a failure this year, owing to the fact that the water supply could not be controlled, as the expected facilities were not available this season.

The pure strains of padi distributed in the Province and in parts of Perak are favourably reported on.

The Assistant Agricultural Inspector, Penang and Province Wellesley, has been informed that a Siamese vendor of seed padi toured the Province this season. The Assistant Agricultural Inspector has seen crops grown from this seed and states that they show every promise of even ripening and a heavy yield.

Investigation have been commenced to ascertain, if possible, why certain bendangs in Kuala Kangsar have given very poor crops of late, whereas they yielded good padi crops some years ago. A good deal of work is anticipated before definite causes can be assigned or definite recommendations be made.

Permission has been obtained to commence some experiments on old dredged mining land with the object of converting it into good padi land. Two companies near Taiping have kindly placed land at the disposal of the Department. One plot is fenced and the other will be in the near future. The plots will be planted up with leguminous crops at the earliest opportunity. Planting has been delayed by the work entailed in controlling the outbreak of Mouldy Rot at Padang Renggas.

Fruit.—Durians in Province Wellesley and Penang were not so plentiful as in the previous season of this year.

Pineapples. Tan Kah Kee's pineapple canning factory at Klang is now open, and producing 20,000 tins (1½ lb.) of cubes or slices daily. The fruit is graded into three qualities selling at $7, $6½, and $6 per case of 48 tins locally. Most of the output is sold in London Liverpool or New York. The price of pineapples at the door of the factory is 2½ cents.

A small factory was opened in the Province in August, but had to close during the quarter as the price of canned fruit fell from $10.50 to $5.50 per case, so that the production costs were not covered.

There is a considerable area of this fruit grown in Southern Johore for canning and three factories are working near Johore Bahru. A small factory is also operating at Kota Tinggi where the cultivation of pineapples is increasing.

Other Crops.—Roselle. A Chinese farmer has been granted the lease of a piece of land near the District Officer's house at Balik Pulau, Penang to grow roselle. This will serve as a demonstration plot.

In Perak South the four demonstration plots in Kinta district have not proved successful, the cause is not clear.

In Selangor the demonstration plot at Tanjong Malim has not proved a success; but that at Batang Kali is progressing well. It is proposed to start 3 plots in Klang district in January 1923.

In Kuantan the Malays have tested locally prepared samples of the fibre and consider it insufficiently strong to be worth planting. I do not understand the reason for this, as the fibre should not be weak.

Enquiries for seed have been received in Negri Sembilan, but the high price of it has deterred possible planters.

The Assistant Agricultural Inspector, Penang and Province Wellesley, records that Chinese near Bukit Mertajam have between 30 and 40 acres of padi land under cultivation of "Ubi Keladi" or "Keladi Chabang." This vegetable is popular with the Chinese and some of it is exported to Perak.

The Assistant Agricultural Inspector, Negri Sembilan, records an application for 10 acres of land for planting Egyptian Cotton. He also notes that a few Chinese vegetable gardeners are planting fruit trees, mostly citrus, in their gardens.

IX. Instructional.

A conference of Malay Officers of the Department was held in Kuala Lumpur on November 20, 21 and 22. The proceedings

included several papers on Co-operation and a visit to Serdang Experimental plantation.

Departmental Examinations were held immediately after the Conference for promotion to the grades of Senior Agricultural Assistant and Junior Agricultural Assistant.

X. General.

The Chief Agricultural Inspector assisted to revise various rules for the importation of plants into the Straits Settlements and Federated Malay States.

Received for publication March 28th, 1923.

NOTE ON BREEDING-GROUNDS OF THE BLACK (RHINOCEROS) BEETLE, *(Oryctes rhinoceros.)*

By G. E. Mann.

THE customary breeding-grounds of the black beetle, viz. decaying cattle-manure or vegetable refuse, are in most cases easily discovered. Two recent experiences, however, illustrate the necessity of being prepared to find such breeding-grounds in unusual circumstances.

In one case, an 8 acre coconut holding was found to have been badly attacked by beetles, but the Malay Inspector had failed to find more than one small breeding-ground, which consisted of decaying leaves and petioles. On further examination, however, it was noticed that the trees had been burned at the base, and that the ash from the burnt rubbish had been heaped round each tree. A casual observer would have thought these heaps to have been completely burnt, as they were quite powdery; but, on opening them up, over 200 heaps were found to be infected, and some 4,800 grubs of the black beetle were collected and destroyed.

In the second case, a few trees were found to have been attacked, but no decaying vegetable matter was discovered until the premises of a Chinese pig-rearer were entered. Several decaying trunks of Kabong (sugar palm), used as a pig-food, were then found to contain grubs.

These two experiences demonstrate clearly the possibility that many breeding-grounds may escape detection unless a detailed inspection is made over the whole area in which grubs may be found, *i.e.* within 400 yards in all directions from the infected trees.

Received for publication March 26th, 1923.

THE FLOWER AND THE BEE.

VERY IMPORTANT LINK IN EVOLUTION.

By Professor J. Arthur Thomson.

Reprinted from The Journal of the Board of Agriculture of British Guiana, Vol. XV, October 1922, No. 4, Page 185

ONE of the main trends of evolution has certainly been to link living creatures together, and one of the most important linkages in history has been that between flowers and useful insect visitors, such as bees. Useful because the bees, in getting pollen and nectar for their own purposes, bring about the cross-fertilization of flowers. And this cross fertilization improves both the quantity and the quality of the seed. Throughout long ages the flowers and the bees if we may keep to bees for a moment, have evolved together, and they are now fitted to one another as hand to glove. In many cases they are nowadays indispensable to one another, for many of the flowers are so specialized that they cannot be fertilized except by bees; while, on the other side, bees are so highly specialized that they would all come to an end if there were no flowers that produced nectar.

Virgin-Birth.

This linkage, like many another, must in some measures determine the lines of further evolution; for the flower cannot safely change in a direction that would shut the door on its visitors; and the bees cannot safely change in a direction that would lessen their success with the flowers. The linkage is part of the well-woven web of life, and it tends, like social linkages of a profitable kind, to keep things from sliding back. One must be cautious, however, for it is possible that without insects to pollinate them flowers might fall back on virgin birth (or parthenogenesis) and that seems to be occuring in such very successful flowers as dandelions. They still produce pollen, but it is not used.

Bees as "Good Botanists."

Inside the seed-box of a flower there are possible seeds or ovules, each containing a single microscopic egg-cell. The possible seed will not become a real seed that is to say, an embryo plant, unless this egg-cell is fertilized. Similarly, no one expects a chick to come out of the unfertilized egg of a hen, and the egg must remain unfertilized if there is no cock in the yard. The fertilization of the microscopic egg-cell of the plant depends on the dusting of the tip or stigma of the pistil with appropriate pollen-grains produced by the stamens of another flower of the same kind. Cases of self pollination, as in peas, oats rice, are in a minority; in most cases the pollen is carried from another blossom by insects or by the wind. A suitable pollen-grain, caught on the moist surface of the stigma, sends out a long

tube which grows down to the ovule, and a male element—little more than one of the nuclei—in the pollen-tube enters into intimate orderly union with the microscopic egg-cell. In the maidenhair tree and a few other primative seed-plants the male element is a freely moving cell, as it is in mosses and ferns and in most animals. In all ordinary flowering plants the male element is a more or less passive cell borne to the egg-cell by the growth of the pollen-tube. But in all cases the essence of fertilization is the same, the intimate union of male-cell and egg-cell : this is the beginning of a new individual.

But this is only an introduction to what we wish to get at—namely, an answer to the difficulty which must rise in the inquiring mind. How is it that the bees do not mix up pollens hopelessly as they pass from flower to flower? If a humble-bee dusts the pistil of a red-clover with the pollen of an aconite, the flower will not be "much forrarder." The answer is threefold. Some insects are specialists they know their flowers "like good botanists," and they keep to them consistently. But, secondly, even when the insect is not a specialist it tends on a given journey or forenoon to keep to one kind of flower. What Aristole observed, the bees do not fly at random from one kind of blossom to another, has been amply confirmed. The mouth parts are suited for particular kinds of flowers; thus the hive-bee's tongue is not long enough to reach the nectar of the ordinary corolla of the red clover which is easily reached by the humble-bee.

News from Scouts.

Moreover, of a summer morning hive-bees pay considerable heed to the tidings brought in by the scouts, who inform them in some way or other which flowers are most profitable at the time. It must be remembered that true bees deal very intimately with the pollen-grains; they moisten them with their mouth and put cakes of them in a depression or basket on one of the joints of the hind-legs, and the next joint is enlarged into a hairy brush. The pollen that is of use to the next flower is the loose dust entangled on various appropriate parts of the bees body, appropriate in the sense that they knock against the stigma and deposit the grains there. Finally, it appears that foreign pollen dusted on to the stigma usually dies; only the proper kind of pollen sends out a pollen tube. Add these three points together - (1) the specialisms of insect visitors,
(2) their consistency on a given journey,
and (3) the specificity of the pollen, which only grows on its appropriate soil (the stigma of its kind), and you have the answer to the question : Why is there not a hopeless mixture of pollen.

How do the Insects "Know"?

But the next question is: How are insects guided to the profitable flowers, or how do they recognise them as the flowers they are out to visit on that journey? The answers given to this question have been so discrepant, some authorities laying emphasis on colour-sense, and others on the sense of smell, and others on memories which

associate certain shapes and textures with abundant nectar, and so on, that we are glad to avail ourselves of Professor Bouvier's recently published "Psychic Life of Insects" (Fisher Unwin, 1922), which takes a critical survey of the known facts.

Many observers have concluded that bees pay most frequent visits to flowers (or even baited paper) with gaudy colours; but there has rarely been any firm discrimination between colour as such and the brilliance of the reflecting surface. What counts for most is conspicuousness against the green background, and bees are in some measure colour blind! Uncovered flowers attract more visitors than the same flowers next door but shaded by leaves; highly coloured flowers with slight odour, like dahlias, attract more visitors than there fragrant unconspicuous neighbours, such as mignonette; conspicuous flowers get far more visitors than honey in a beaker next door.

The conspicuousness may depend on form and size as well as colour, as is shown by the attentions some butterflies pay to the big white flowers of the field convolvulus. The visits cease when the corolla is removed, though the nectaries remain intact. Yet after some time various kinds of insect visitors undoubtedly learn to come to honey-flowers whose petals have been cut off. This is a very suggestive fact.

"Never Trust to Colour."

Then there is fragrance, which certainly counts for much among hive-bees, for they are very richly endowed with smelling hairs. Darwin said that "bumble-bees and honey-bees are good botanists" because they recognise the same kind of flower though the colour is different. They obey the advice of the father of botany. "Never trust to colour." It is probably the flower's characteristic perfume, mainly due to essential oils, that enables the bees to become "good botanists." Kerner saw a convolvulus hawkmoth fly straight to the invisible flowers of a honeysuckle over a hundred yards away. For a long range, then, where colour, brilliant surface, and shape cannot count as guides, certain insects, like bees and moths, may be attracted by odours diffusing through the air. When they come near, the other influences may tell. On the other hand, a bee attracted to a flower by its conspicuousness may turn away when it detects the perfume.

The Role of Learning.

The question of the guidance of insect visitors to useful flowers has got into some confusion because different insects are differently attracted, and different flowers have different advertisements. Each case must be studied by itself. But there is more than that. Too little attention has been given to the capacity insects have of profiting by individual experience. They are not altogether instinctive automata; they are intelligent learners. They can attend and they can remember. They can build up associations between certain advertisements (colour, shape, fragrance) and good meals. Forel showed that bees learn to force their way into flowers covered up by leaves; Perez showed that

bees learn to visit the scarlet pelargonium, which they dislike, provided a little honey is introduced for a while into the corollas ; Bouvier and others have shown that hive-bees learn to profit by slits and holes which other bees have made as short cuts to the nectaries; and many observers have noticed that bees learn to give up visiting flowers which promise well but are in reality disappointing. No doubt bees are dominated by their hereditary inborn instincts, but we fail to make sense of their behaviour unless we also give them credit for an intelligent criticism of advertisements.

DEPARTMENTAL NOTES.

Mr. A. G. G. Ellis, Inspector of Agriculture, Johore, proceeded to Europe on vacation leave on August 5th, 1922, and resigned the service on November 21st, 1922, for family reasons.

Mr. Ellis joined the department on May 3rd, 1913 as an Assistant Agricultural Inspector and was placed in charge of Perak North. His headquarters were at first in Kuala Kangsar, but after a few months were moved to Taiping. Mr. Ellis remained in Perak until January 27th, 1919, when he was appointed to act as Chief Agricultural Inspector during the absence on leave of Mr. F. W. South. While in Perak Mr. Ellis did valuable work in organising the then newly established inspection division there and in carrying on the work on sound lines. On at least two occasions he was for a period in charge of this work in the whole State.

Mr. Ellis proceeded on leave to Europe on November 23rd, 1919 and returned on April 22nd, 1921. He was seconded for service as Inspector of Agriculture, Johore on May 19th, 1921, and proceeded to reorganise and develop the local department in that State.

Mr. Ellis was an energetic and capable officer who had done much useful work. It is unfortunate that he has had to resign a promising career after nine years service. The departure of so experienced an officer is a serious loss to the department.

Mr. A. E. C. Doscas, Assistant Agricultural Inspector, Negri Sembilan, was seconded to act as Inspector of Agriculture, Johore, in place of Mr. Ellis on August 3rd, 1922 (*Vide* Notification No. 5337 in the Federated Malay States Government Gazette of September 8th, 1922).

Mr. W. H. Barnes, Special Field Officer, Kuala Pilah was appointed to act as Assistant Agricultural Inspector, Negri Sembilan, in place of Mr. Doscas (*Vide*-Notification No. 5336 in the Federated Malay States Government Gazette of September 8th, 1922).

April 30th 1923.

THE

Malayan Agricultural Journal.

Vol. XI | May, 1923. | No. 5.

RICE IN MALAYA.

BY H. W. JACK.

INTRODUCTION.

THE importance of cereals as the most valuable of economic crops has been fully recognised from earliest times. History tells us of their cultivation more than 4,000 years ago and their significance in the rise and fall of Empires right down to modern times, even the Germans had hopes of victory in the Great War through starvation of their enemies by cutting off food supplies (mainly cereal) in their submarine compaign.

Neither public works nor industrial pursuits of any kind can be carried on without ample supplies of the "staff of life" for our toiling masses. It may be remembered that the problem of obtaining adequate quantities of rice and other food-stuffs for our people greatly perplexed this Government during 1917 and 1918 when attention was directed to the forced restriction on the importation of food-stuffs into this country due to the war and the consequent lack of shipping, and strenuous efforts had to be made to encourage local production.

Rice was regarded as the most important crop in China in 2800 B.C. (1) and it is now the staple food of over 60% of the population of the world (2) and this percentage is likely to increase because, under suitable conditions rice is cheaper to produce than any other cereal. In Malaya over 99% of our population depends entirely on rice for their subsistence (3) and yet the country only produces approximately two-fifths of our annual consumption. Furthermore, only 16% of the population is engaged in rice cultivation. This is an undesirable state of affairs, as will be readily acknowledged by all who resided here during the rice shortage which was felt so keenly a few years ago: it is consequently one of the prime duties of the Government to encourage the local production of rice, and efforts are being made in this direction. Much is being done in a quiet way by (*a*) District Officers who aim at getting all suitable land in their districts planted up with

1. Commercial Products of the World—Freeman & Chandler.
2. Philippine Agricultural Review, Vol. XIV, No. 1., 1921.
3. Federated Malay States, Census Report, 1921.

rice each season, (*b*) the Irrigation Department in finding irrigable areas and establishing water supplies for them and (*c*) the Agricultural Department in carrying out experimental research with the object of improving methods of cultivation of padi and increasing the yield of crops by the breeding and distribution of selected seed. Although the Malayan Rice Industry is here dealt with in a general way yet the main object of the author is to place on record the progress made with the experimental work conducted during the past six years by the Botanical Division of the Department of Agriculture,

I.—Distribution and Areas.

The rice-growing areas of Malaya are scattered throughout the Peninsula as depicted in the attached distribution map, but considerably more than half the total area is found in the States of Kedah and Kelantan where 80% of the population is Malay. In Singapore and the Dindings there is practically no cultivation of rice, and of the Federated Malay States, Perak is the only large producer. On the western side of the Peninsula, the chief padi areas are confined to the flat coastal lands of Kedah, Province Wellesley and Malacca where the crop depends entirely upon rainfall, and to the Krian district of Perak where the land is irrigated. On the East Coast the bulk of the crop comes from inland, the water-supply being dependent on seasonal rainfall which raises the river levels thus flooding adjacent rice land. Table I shows the areas, percentage of entire area and area in acres per head of population under rice in each State in 1921, and total area under rice (wet and dry) in Malaya.

Province or State.	Area in acres.	Area under rice.	% of total area.	Population 1921.	Area under rice per head.
Kedah	2,334,720	174,000	7.4	338,558	.51 acre.
Perlis	292,000	31,000	15.3	40,087	.77 ,,
Prov. Wellesley	179,460	33,500	18.33	130,341	.26 ,,
Penang Town	6,080	nil.	nil.	123,069	nil.
,, Country	63,750	6,030	8.6	39,075	.15 ,,
Dindings	117,120	720	.6	11,850	.06 ,,
Perak (including Krian)	5,010,000	119,505	2.3	599,055	.2 ,,
Krian	201,400	55,000	27.	85,911	.64 ,,
Selangor: -					
K. L. Town	11,000	nil.	nil.	80,424	nil.
Sel. Country	2,037,000	18,110	.9	320,585	.06 ,,
Negri Sembilan	1,632,000	30,100	1.9	187,762	.16 ,,
Pahang	9,152,000	80,025	.3	146,064	.2 ,,
Malacca Town	3,240	nil.	nil.	30,671	nil.
,, Country	460,400	27,622	5.9	122,851	.22 ,,
Singapore	145,000	nil.	nil.	425,912	nil.
Trengganu	3,840,000	10,800	.28	153,765	.07 ,,
Kelantan	3,756,800	175,050	4.66	309,300	.58 ,,
Johore	4,800,000	13,200	.27	282,234	.05 ,,
Total	33,870,570	669,262	1.98	3332,603	.204 ,,

Reckoning on an average production of 250 gantangs per acre per annum (which is higher than the actual average) 5 acres of land under rice per head of population is necessary to render the country self supporting.

This satisfactory state of affairs is only achieved in Krian, Kedah, Kelantan and Perlis where Malays predominate by a large margin and where the above mentioned average yield is approximated. Throughout the rest of the country the population includes masses of immigrant Indian and Chinese coolies employed on the estates and mines, who have no chance of growing their own rice and are dependent on supplies imported from Burma and Siam.

The average yield for the whole country (wet and dry padi) is only 203 gantangs (gallons) and only one-fifth of an acre is cultivated per head of population whereas at the average rate of production it would be necessary to cultivate .62 acre per head of population in order to render the country self-supporting. This matter will be discussed later in a chapter on *Economics*.

The area under rice varies slightly from year to year in each State, the variation being chiefly dependent on rainfall at or just prior to the sowing time, and the market price for padi, though other factors sometimes also influence cultivators. For example, the rice shortage and consequent high prices greatly stimulated production in season 1918-19 and the present depression of the rubber industry is also having a similar effect. Rice lands which have been abandoned for years are now being brought into cultivation again, and there is a demand for good new land.

The distribution of rainfall is, however, the chief cause of variation for it affects crops in all stages of growth. Drought occasionally renders it impossible to sow rice nurseries. Again young healthy plants may wilt and die because of dry weather early after the planting season. Sometimes large areas of newly planted land are devastated by floods whilst heavy crops are often seriously diminished by continued rains at harvest. Thus, the Krian crop which promised good results just before harvest 1921 was extensively damaged by continuous rainy weather with a consequent loss of 30% of the crop which was estimated at 15,500,000 gantangs before harvest, so that it is hardly possible to estimate with accuracy the value of a crop until it is safely garnered.

Table II shows the variation in area under rice in the main rice producing districts of Malaya during the last 7 years.

Table II.

Area under Rice in Seasons 1915-1922.

District.	1915-16.	1916-17	1917-18.	1918-19	1919-20.	1920-21	1921-22	Average.
								Acres.
1 Krian	52,294	50,606	48,546	50,070	52,834	54,373	54,870	51.942
2 Kuala Kangsar	6,899	5,965	11,029	12,262	16,862	17,978	17,620	12,673
3 Malacca	27,520	27,455	26,640	29,230	27,265	28,835	26,409	27,622
4 Kota Bharu	..	..	..	.	115,000	148,000	124,00	129,000
5 Pasir Puteh	..	..	..	..	27,000	43,000	44,000	38,000
6 Penang	5,960	5,890	6,210	6,465	6,335	6,170	5 180	6,030
7 P. Wellesley	33,600	30,540	26,800	32,740	26,238	41,000	31,000	33,131
8 Lower Perak	4,400	2,082	4,138	9,894	13,952	11,836	10,724	8,146
9 Kuala Pilah	13,823	14,118	13,898	14,057	13,778	14,2 2	14,609	14,069
10 Rembau (Sub-district)	4,374	4,711	4,348	7,281	7,758	7,635	7.462	5,158
11 Pekan	3,424	3,910	5,005	5,244	6,300	5,818	3,767	4,781
12 Upper Perak	5,753	4,142	5,430	5 904	7,340	9,360	5.479	6,201
13 Larut & Matang	9,252	8,918	9,874	10,469	12,899	13,401	13,864	11,239
14 Batang Padang	1,394	1,145	2,435	4,066	11,414	9,503	8,281	5,462
15 Kuala Selangor	4,172	2,505	1,290	1,851	6,215	8,764	11,331	5,161
16 Seremban	3,448	3.134	3.292	3,313	3,757	4,144	5,248	3,762
17 Tampin	5,998	5,898	5,585	8,600	9,049	8,982	8,992	7,586
18 Kuala Lipis	6,973	7,011	7.391	7,052	7,855	7,734	7,628	7,378
19 Raub	4,367	4,073	4,709	3,424	5,837	4,798	6,197	4,772
20 Temerloh	8,089	8,699	8,957	7,693	10,139	8,935	10,891	9,057
21 Kota Star	..	..	..	..	69,630	68,380	67,450	68,486
22 Kubang Pasu	..	..	.	..	19,284	..	20,929	20,106
23 Muar		.	..	..	4,530	5,260	7,890	5,893

Though by far the larger area under rice in Malaya, is devoted to wet rice cultivation, the area under dry land rice is considerable amounting to 43,130 acres annually.

Table III. shows the chief dry rice producing districts and the variation in area in acres in each year for seven years.

Table III.

Area under Dry Padi in Acres-Seasons, 1915-1922.

	Upper Perak.	Larut and Matang	Kuala Kangsar.	Kinta.	Batang Padang.	Lower Perak.	Kuala Selangor.	Ulu Selangor.	Kuala Lipis	Pekan.	Padang Trap.	Muar.
1915-16	512	298	370	1152	776	3220	3822	650	2868	1293	600	—
1916-17	826	70	345	191	856	1732	2155	178	2819	1294	1000	—
1917-18	1372	190	769	970	2190	3107	933	196	2502	1220	1400	—
1918-19	1963	442	952	2576	3200	7811	1513	1016	1943	'167	2300	1250
1919-20	3421	2928	4258	6745	10194	11607	1515	2138	2789	1506	2960	1980
1920-21	5000	3015	3300	6398	8415	9604	624	2702	2701	2155	3300	1500
1921-22	1330	1563	2665	4861	7638	8058	336	2420	2193	803	3201	2476

Variation in the area under dry rice is more marked than in the case of wet rice, because land suitable for dry rice cultivation is more abundant and more rapidly available than for wet rice, hence the area under dry rice is more rapidly influenced by changes in the market price of rice than is the case wifh wet rice areas. Also dry rice cultivation is possibly more dependent on rainfall than wet rice since the latter is unusually grown in localities there percolating water collects, in contrast to the dry rice areas which are more commonly found on sloping land and thus depend chiefly on the the precipitation of rain.

II.—IRRIGATION.

Irrigation on a small scale is a common practice in Malaya, the Malays displaying remarkable aptitude in diverting small streams so as to get the maximum utility from them. Temporary weirs of logs, bamboos, matted sticks and earth are commonly constructed to deviate the water of the larger streams and rivers into distribution channels for irrigating fairly large areas such as those along the Perak River. In Pahang and Kelantan where practically all the padi land is situated on the alluvial flats following the river courses, the water-supply depends on the overflow of the banks of the rivers during the more or less regular rainy seasons.

Water-wheels and other ingenious mechanical contrivances for raising water are employed to irrigate small areas as in Upper Perak, Kuala Pilah and elsewhere. Under special conditions, terracing is practised, the edges of terraces being thrown up into small well compacted ridges in order to contain the water which is distributed by gravitation and percolation.

Permanent adjustable dams are frequently erected in the streams or in specially constructed canals for flooding large flat areas as in Malacca, while fixed bunds have been made in several flat areas where the water supply is entirely dependent either on rainfall as for instance in Sabak and Kedah, or on the overflow from rivers as at Pekan. There are numerous small low-lying areas which are converted into swamps in the wet weather by their natural configuration where no form of irrigation is necessary, but crops on this type of land are precarious.

In certain tin-mining districts, Gopeng for example, water in supplied over long distances to very small blocks of padi land in miniature aqueducts constructed from various mateiials such as large bamboos, split coconut or nibong stems. When the source of supply is adjacent and has only to be raised, several ingenious methods are employed. An empty kerosine oil tin with the top removed or a closely woven basket is held by ropes worked by two labourers who swing the tin (or basket) into the water and continuing the swing upwards empty it at the higher level into a tank or channel from which it flows to the field which is to be irrigated. When the supply is derived from a percolation well or when there is a lift of 15·—20 feet a bucket is suspended from one end of a long beam which is pivotted to a post near the other end, so as to revolve through a vertical plane. The shorter end is weighted so as almost to counterbalance the weight

of the full bucket and the longer arm, and one coolie adds the extra pull and empties the bucket each time it reaches the desired level.

The Government is endeavouring to encourage the extension of padi cultivation by placing more irrigable land at the disposal of cultivators and table IV, kindly supplied by the Irrigation Department, shows what schemes are projected and area of land which each scheme is expected to irrigate.

TABLE IV.

Approx. Acreage.					
				Acres	
1	Krian	in	North Perak	56,000	Completed
2	Gua Badah	,,	Lenggong	1,000	,,
3	Kenas	,,	Kuala Kangsar	2,000	Under Construction
4	Pulau Tawar	,,	Jerantut	1,800	(Nearly Completed)
5	Batu Kikir	,,	Kuala Pilah	4,600	Surveyed
6	Terachi	,,	,, ,,	not reported	Being surveyed
				Acres	
7	Dong	,,	Raub	250	Partly surveyed
8	Lawin	,,	Grik	300	Surveyed
9	Ibul	,,	Lenggong	200	,,
10	Briak	,,	Bukit Merah	5,330	Surveyed & partly drained
11	Lower Perak	,,	Lower Perak	142,000	Preliminary survey
12	Bota	,,	,, ,,	4,000	Surveyed

In addition to the work outlined in Table IV. the Irrigation Department performs many minor works for improving existing natural and artificial water supplies and considerable assistance is rendered to settled cultivators every year by District Officers and others for the upkeep of water-courses, bunds and dams throughout the country.

Moreover, in certain districts where irrigation is possible the District Officers are endeavouring to extend or introduce the cultivation of padi, by offering land to probable settlers on particularly attractive terms. Thus one large area of about 100,000 acres in the Kuala Selangor district which is still under jungle and where the water supply in abundant has been reserved for padi cultivation and settlers are only given titles to land on condition that they plant a definite amount of padi annually.

This policy might be more widely adopted and all land suitable for rice cultivation and where water is readily obtainable might be offered to cultivators for padi cultivation on particularly attractive terms so as to induce Malays to settle and grow their own crops.

The importance of irrigation for wet rice cultivation cannot be over emphasised since the water supply is the chief factor which determines between good and bad crops, on average land. The amount of irrigation required depends on the physical characters of the soil and the variety of padi planted.

Deep soils or soils without an underlying layer of impervious heavy clay or a hard subsoil require more water than soils which possess either of these foundations. The ideal padi soil is a fairly rich loamy clay some 4 to 6 inches deep, with an impervious layer of heavy clay underlying it. Such a soil, provided that it is fairly level, is easily irrigated since the impervious layer makes it possible to inundate the land for a long period with the minimum supply of water

On areas where irrigation is not controlled systematically there is a tendency to maintain too great a depth of water in the rice fields while even in areas where the irrigation is controlled too much water is a more frequent occurrence than too little and consequently much water is wasted. Of course, on large areas discrepancies of land level sometimes render it impossible to keep the depth of water uniform, since in order to irrigate slightly elevated patches, the deeper water in the depressions is unavoidable. Even when due consideration is given to this point, too much water is frequently maintained on the land for padi only requires from four to six inches of water during its period of vegetative growth. The length of this period, ofcourse, depends on the variety of padi grown, but whatever the variety it is advisable that the land should be drained off completely six to eight weeks before harvest. Irregularities in the depth of irrigation water interrupt the uniformity of the ripening of padi to some extent and hence unit areas should always be levelled as thoroughly as possible, for the purpose of irrigation. Irrigation of suitable land would go far to extend the present area under rice in Malaya, for wherever good average land is adequently irrigated. it would attract settlers and good crops would be produced from areas now lying idle.

III. SOILS.

The wet rice soils of Malaya are confined to the alluvial tracts on the west coast and all along the banks of the rivers throughout the Peninsula. Geological and biological evidence favour the view that most of the coastal rice land, figuratively speaking, is land recently reclaimed from the sea by gradual elevation (1) portions of it still being within tidal influence. The dry rice soils mostly follow the rivers but are situated higher up the valleys, in low foot hills and even on the steeper hills where rich loams are encountered.

Soils are classified by Hilgard (2) according to the amount of clay which they contain and rice is only grown satisfactorily in Malaya on clay loams (15-25% clay) clay soils (25-35% clay) and heavy clay soils (35% clay and upward) and its growth is so seriously arrested when the proportion of sand increases beyong 55% as to render the production uneconomic.

Table V. (compiled from records prepared by the Chemical Division of the Department) shows the results of chemical and mechanical analysis of typical rice soils.

TABLE V.

CHEMICAL ANALYSIS.

No.	Moisture.	Loss on heating	Potash	Available Potash.	Phosphate.	Available phosphate	Lime.	Magnesia.	Nitrogen.
1	5.1	12.85	.540	.0794	.0648	.00454	.13	.16	.209
2	2.3	8.1	.555	...	.041	...	.117	.176	.246
3	4.7	12.1	.55	.0388	.06	.0084	.19	.52	.386
4	2.3	11.3	.403	.0186	.104	.0094	.04	.17	.118
5	3.0	11.6	.172	.0084	.0511	.00949	.1982	.088	.201
6	1.54	9.1	.139	.0058	.029	.00135	.089	.044	.20
7	2.1	8.2	.241	.0054	.045	.0048	.15	.24	.123
8	2.0	8.2	.154	.00845	.0287	.00187	.128	.036	.081
9	.98	5.7	.0245	...	.0156	...	.07	.15	.17
10	1.7	32.0	.215	.0601	.0718	.01180	.12	.25	.639

MECHANICAL ANALYSIS.

No.	Locality	Humus	Clay	Fine silt	Silt	Sand	Class of land
1	Krian	4.0	57.7	20.9	15.3	2.0	1st.
2	Kedah	...	28.2	58.1	10.5	3.2	1st.
3	Kedah	...	31.1	31.7	27.2	10.0	1st.
4	K. Kangsar	...	26.2	50.4	15.3	7.1	1st.
5	Jelebu	4.0	17.5	32.8	16.3	29.4	2nd.
6	Kuala Pilah	...	17.6	28.1	16.6	37.7	2nd.
7	K. Kangsar	...	18.6	27.4	14.0	40.0	2nd.
8	Jelebu	1.6	19.1	30.2	7.3	41.8	2nd.
9	K. Kangsar	...	6.9	10.2	14.0	68.9	3rd.
10	Krian (peaty)	12.8	.28.9	34.6	15.6	8.1	3rd.

In the above table of analyses the soils nubered 1 to 4 are typical of the best rice soils in Malaya in that they contain a high percentage of clay and fine silt and very little sand. They are all low-lying heavy clays rich in potassium and phosphorus and other essential plant nutrients and are capable of producing at least 500 gantangs of padi in an average season.

Soils numbered 6 to 8 are placed in the second class as crop producers on account of their lower percentages of clay, higher amounts of sand and smaller quantities of potash constituents. These soils, under the best forms of irrigation do not produce over 450 gantangs per acre. The general average is smaller than this and under ordinary conditions 250-350 gantangs may be take to represent an average crop.

Soil number 9 is useless for padi cultivation because of its very high proportion of sand and its very low supply of plant food. This type of soil is only cultivated when no other land is available or in a season of rice shortage when prices are high.

Soil number 10 is rendered uneconomic for padi on account of its peaty nature, though in other respects its composition would place it in the first class. Sand and peat are detrimental to the growth of the rice plant, the former because of its deficiency in plant food and its failure to retain moisture and the latter because of its humic and other organic acids which kill the young roots. Three to four inches of surface peat convert otherwise first class land into third class. Experience and analysis show that physical texture and the condition of the soil are more important factors from the point of view of rice production than chemical composition. All clay soils are rich in potassium. The supply of nitrogen as revealed by analysis is abundant, moreover considerable quantities of this element are brought to the land by the irrigation water in the form of nitrates and ammonia; also further quantities accumulate between the padi seasons as a result of the growth of weeds which is subsequently cut down and ploughed under or permitted to rot on the surface of the soil.

Of the three most essential elements phosphorus is present in the soil in by far the least amount, but at the same time, even soil number 9 which is the poorest in this constituent, could supply sufficient to meet the requirements of at least 20 crops of rice, reckoning that an average crop of padi takes 9.53 lbs. of phosphorus calculated as phosphate (8) from the soil. Thus it can be seen that as far as the chemical composition of the soil is concerned, all our ordinary soils contain the food requirements of the padi plant.

On the other hand the effect produced by differing amounts of sand, clay and peat in the soil are striking, so much so that the amounts of each afford a ready guide to the classification of soils as first, second or third class as rice producers. The following table shows roughly the limits of variation in the percentage of these constituents in the different classes of rice soils.

TABLE VI.

Class.	Humus.	Clay.	Fine silt.	Silt.	Sand.
1st.	3 to 7	25-65	20-60	10-25	2-10
2nd.	2 to 5	15-30	25-40	15-35	20-40
3rd.	1 to 3 (peat excepted)	5-20	5-20	15-40	35-70
Peaty.	over 10	15-40	20-50	5-15	0-10

The above table can be used with confidence in adjuding the suitability of any soil for the cultivation of padi, provided that due consideration is given to the question of water supply.

1. Geology of South Perak North Selangor and the Dindings – Scrivenor and Jones, Geological Department F.M.S., 1919.

2. Soils — E. W. Hilgard, 1907.

3 Some Rice Soils - M. Barrowcliff - Agr. Bull. F.M.S , Vol I, No. 12, 1913.

IV CULTIVATION.

Soils vary from place to place and since the nature of the soil determines the method of cultivation, methods vary in different States and districts. The main points of variation are (1) the preliminary preparation of the soil, (2) the preparation of the nursery, (3) the degree of tillage, (4) the practice of manuring, (5) the methods of sowing, (6) the number of transplantations. (7) the amount of weeding and (8) the method of harvesting.

Broadly, there are two types of cultivation, (a) Wet rice cultivation and (b) dry rice cultivation, though methods vary within these two classes according to local custom and the nature of the soil.

(a) *Wet Rice*:—Generally the harder lands are ploughed or 'chankolled' as soon as rains render them sufficiently soft, then they are freely watered, cleared of weeds by a buffalo-drawn rake, and rolled into a homogenous slime, the amount of ploughing, rolling and raking depending on the condition of the soil, the availability of cattle and the industry of the cultivator. Frequently, the masses of rank grasses which have been produced during 4 to 5 months of fallow have to be cut down before ploughing and are then allowed to rot on the surface of the soil. This practice makes ploughing less arduous, adds humus to the soils and greatly benefits the crop. All the implements used are primitive in design and construction but very effective when diligently used.

The native plough is a much maligned implement and is held responsible by many people for the unsatisfactory padi crops. This is not the opinion of the author. Poor crops are more often due to dearth of buffaloes which results in too scanty tillage of the soil. The plough possesses the advantages of being light and of easy draught and together with its handle, is carved out of a single piece of hard wood and shaped so as to turn the top 4 to 6 inches of soil. The beam is fixed immoveably to the plough and is more often arranged for fitting to a pair of bullocks or buffaloes, though a single draft arrangement is also common. The roller consists of a cylindrical hard wood beam some 14 inches in diameter and 4 to 5 feet long with stout cylindrical flanges protuding some 1-5 inches at each end, to which rattan ropes are fixed for hitching the roller to the draft animals. Along the length of this beam, six triangular grooves about 2 inches deep are carved, the uncarved portions thus forming ridges which bury the few weeds left after raking, break the clods and pulverise the lumps of clay, so that eventually the soil is brought to a very even tilth. The rake is used to clear up the weeds and pulverise the soil. Various

manurial materials, usually insufficient in amount, may be incorporated with the soil after ploughing but before rolling, the most common fertilisers being bat guano, bonemeal, ashes and cowdung, according to their availability and cost. The subject of manures will be discussed later. In these harder soils the use of "dry" nurseries is more common than that of "wet" nurseries, that is, the nursery is situated on a piece of land which is not liable to inundation. The nursery soil is usually dug over and thoroughly cultivated to a depth of 8-10 inches though sometimes the operation is limited to cleaning the top soil only, and the seed, either dry or after 24-48 hours soaking in water, is thickly broadcasted and covered by sweeping the surface with tree branches or by ploughing lightly. Frequently, the nurseries are manured with ashes, burnt earth, or bonemeal.

Failing showery weather, the nursery is watered at least once daily, and continued, if possible, until the young plants are between 40 and 50 days old when they are ready for transplantation into the fields. Before this is done, the nursery is heavily watered to soften the soil and then the seedlings are pulled up, their roots being thoroughly cleared of nursery soil. Following this they are tied in bunches which are kept moist and cool, ready for planting. Sometimes the bunches of seedlings are placed in a manure paste, commonly consisting of guano, cowdung or bonemeal, or mixtures of these ingredients; a practice which distributes the manure very evenly, but the total amount of manure used is small.

In some of the coastal districts rice lands consisting of very heavy clays become so soft and plastic when inundated with water that ploughing and rolling can be dispensed with. Here the only cultivation necessary is a thorough clearing away of the heavy growth of weeds and grasses which usually covers such lands to a depth of 3-4 feet in the fallow season.

The irrigated area in the Krian district, comprising 55,000 acres, is the largest block of land in which this form of cultivation can be practised with success, but it is also applied in the coastal parts of North Kedah, in many of the valleys in Perak and in the southern parts of Province Wellesley. The method of cultivation in Krian has been described in detail in Bulletin No: 32 (1) of this Department and that method applies equally to most of the softer padi lands in the country except in the matter of destroying the weeds and grass. In Krian, and several other areas, fallow vegetation is cut down by means of a "tajak" (a short heavy scythe-like instrument which the cultivator swings from above his shoulder) at the surface of the soil as soon as water covers the land to a depth of a few inches. The cut grass is permitted to rot on the land for 4-6 weeks and is then removed to form the divisions ("batas") which separate each man's holding.

In locatities other than Krian, buffaloes are sometimes driven on to the land to trample the grass into the soil, where it rots and adds greatly to the organic matter in the land. For most of the softer type of soils wet nurseries are employed, though they are frequently used for supplying some of the harder

areas also. In the preparation of a "wet" nursery on the softer inundated lands, the fallow grass is cut and piled up into a long strip usually 3-4 feet wide, until the pile stands about an inch above water level. On this grass foundation sufficient clay is plastered to make the whole into a compact bed on the top of which a thin layer of mud rich in humus is finally laid to complete the seedbed. Thus, should the level of the water in the fields rise, the nursery, rendered buoyant by its grass foundation, floats and maintains its surface above water level. The construction of a 'wet' nursery in the harder lands is a more arduous task as the soil has to be throughly cultivated, then irrigated and puddled to a fine mud before the seed can be sown. For both types of seedbed the seed is commonly soaked in water for 1—2 days and then maintained in a moist condition for a further period of 1—2 days until germination has commenced. It is broadcasted thinly on the nurseries intended for planting the harder soils, whereas for sowing the softer lands the seed is sown thickly and two transplantations are usually required. For the production of good crops of padi in the softer soils, transplantations are found necessary, since otherwise the vegetative growth is rank at the expense of the grain. The amount of seed required to plant an acre of land varies with the fertility of the soil. On the best land three "gantangs" (gallons) are sufficient, the quantity making ample allowance for damage due to pests, while medium land requires 4 to 5 gantangs and poor land as much as 6—7 gantangs per acre. In some areas nurseries are dispensed with, the seed being broadcasted directly in the fields after ploughing and rolling. This method is in vogue only where the water can be run off the fields a few days after sowning unsoaked seed and run on again after the young plants are several inches high.

(*b*) Dry Rice.

Dry land rice is a more precarious crop than wet rice because it is absolutely dependent on rainfall which must be evenly distributed for about 3 to 4 months if a satisfactory crop is to be reaped. Rain is essential to germinate the seed and start the growth of the young plants, which, once thoroughly established, can thrive under conditions of so small a water-supply as would ordinarily spell complete ruin to the growth of "wet padi" varieties. There are, however, exceptional types which have been found to produce economic crops when grown either as wet or as dry padi.

Two methods of cultivating dry rice are in vogue.

(*a*) "Ladang," "Tanah tugal," Huma" or hill cultivation.

This primitive and easy method of exploiting virgin soil consists, in its simplest and most wasteful form, of the utilization of the rich newly burnt jungle to the production of two or at the most, three annual crops of cereals. Generally the sides of low hills, or undulating jungle lands, are chosen for this type of cultivation. Sometimes land utilised several years previously and carrying a thich growth of secondary jungle, is used again. The land is first cleared of its thick growth of underbush, then the larger trees are felled and the whole

burned. After the first burning the remaining branches are piled against the larger tree trunks and fired a second time. These operations are usually timed so as to be completed just at the beginning of the rainy weather. After the first heavy rains have fallen the seed is sown. The actual method of sowing the seed as the Malay term "tugal" implies, consists of dropping several (5-15) seeds into shallow depressions made by a stake with a rounded end, the seeds being subsequently lightly covered with soil by the foot of the sower. The holes are usually spaced about one foot apart each way, the seeding rate per acre being 1-3 gantangs of padi according to the skill of the sower. Sometimes the seed is broadcasted requiring about ten "gantangs" of seed per acre. The better class of cultivators weed their clearings once some 6-8 weeks after planting, and rarely twice. whereas the aborigines (Sakai) never weed their clearings by any chance. Many "ladang" cultivations are almost intensive in their nature being sown with the quicker growing maize (*Zea mays*,) or the "menjelai" (a soft shelled form of Job's Tears (*Coix lacryma jobi*) crop at the same time as with rice. These catchcrops rapidly develop long erect stems with leaves which produce little shade effect on the padi. Under good conditions this type of cultivation can be made to yield up to 350 gantangs of padi to the acre as a first crop on newly cleared jungle land, the yield for a second crop being limited to about 250 gantangs. A third crop rarely produces more than 150 gantangs per acre. Only on specially rich soil is a fourth crop attempted and the yields mentioned, though produced, are rarely obtained, because of the incidence of various pests, particularly birds, pigs and rats.

Though this form of cultivation is primitive in character yet it has been evolved by long experience. The underlying principles of the practice are sound from certain points of view because two or three crops of padi can be produced with little labour beyond the initial felling of the jungle; the competition of noxious weeds is reduced to a minimum and injurious pests and diseases are destroyed.

Again, the partial sterilization of the soil which results from the burning of jungle on newly cleared lands is no doubt beneficial, but whether this temporary increase in fertility is commensurate with the tremendous loss of valuable organic matter destroyed by fire is very doubtful, at most, the practice is economically unsound in that large areas of valuable forest and fertile soil are destroyed or lost for the low value of two or three small crops of padi. On the other hand on old established holdings where the fertility of the soil is much reduced and where there is no readily available source of organic material to supply the requirements of the padi plant, then the practice of partial sterlization is certainly beneficial to the succeeding crop.

Referring to the effects of heating soils it has been shown by Russell and Hutchinson (2) that partial sterilization of the soil by moderate heating results in a great increase in the amount of ammonia present in the soil, due to the enormously increased bacterial flora. Soil protozoa, which succumb to the heating of the soil more readily than the bacteria on which they feed, are so greatly depleted in number that, after partial sterilization, they are unable to limit the numbers of bacteria, which multiply more rapidly than do

the protozoa. Hence there is a temporary increase in the numbers of bacteria, until the normal number of protozoa is restored and this temporary increase in the number of bacteria results in an excess of ammonia because of the increased decomposition of soil substances by bacteria. Not only is the productivity of the soil increased by partial sterilization, but there is also an increase in the rate of growth of plants grown in such soils, as Russell and Petherbridge (3) have demonstrated." These phenomena have only been discovered in the last decade and yet the hill padi planter has taken advantage of them, probably, for hundreds of years, in the practice of burning the scrub and timber on his clearings and thus unconciously increasing the productivity of his land by the partial sterilization which such heating of the soil affords.

It has been shown by Thompstone (4) that in place of partially sterilizing soils by heating them and thus rendering them temporarly productive, continuous profitable cropping can be effected by the application of lime and organic manures combined with rotations of crops, but much propaganda is necessary before Malays are likely to be induced to modernise their methods of "ladang" cultivation. particularly as land is at present abundant and food relatively cheap.

(*b*) Tenggala or plough cultivation : —

This method of dry rice cultivation might have great possiblities if our Malay population was of a more industrious disposition as it can be applied to almost any type of flat or gently undulating loamy land, its essentials, like cereal cultivation in Europe depending on thorough tillage of the surface soil and rainfall. The areas at present under this method of cultivation are almost limited to the flat alluvial stretches following the meanderings of the Pahang River, but they might be vastly extended should the necessity arise, provided that a sufficient number of buffaloes was available or it was found practical to provide and work motor ploughs, along communal lines. The land, which in fallow, supports a sparse growth of grasses and "blukar", (secondary jungle growth) receives scant cultivation partly because of the slackness of the cultivators, but also because the supply of buffaloes for ploughing is often insufficient. The land is cleared of "blukar" including the extraction of the roots. It is then ploughed lightly 3 times, the direction of each successive ploughing being at right angles to the previous one, and finally raked with a coarse buffalo-drawn rake ("sikat") which has much the same effect as a harrow on the soil. This constitutes the entire cultivation which is good as far as it goes except that no manures are distributed or mixed with the soil, and the tilth is not sufficiently deep, being limited to about 4 inches.

The seed, previously germinated, is broadcasted at the rate of 10 gantangs per acre, the land being divided into narrow strips for the purpose of assisting in the even distribution of the seed, which is afterwards lightly covered by drawing branches across the fields or raking lightly or ploughing.

Weeding, which would probably benefit the crop, is rarely practised unless unfavourable weather conditions retard the growth of the rice, thus giving weeds a chance in the struggle for light and food.

The yields derived from this method of cultivation compare favourably with those obtained by the "ladang" method, but the annual diminution in yield is not so marked as in the latter case and a longer succession of paying crops can be reaped than is possible under "ladang" cultivation. "Tenggala" land is usually cultivated for 3 or 4 years in succession and then fallowed for a similar period, though crops are sometimes taken for 5 or 6 years, especially in areas which are enriched annually by floods from the rivers.

The scope for improvement of this method of cultivation is wide, including the introduction of crop rotation with special reference to green manuring which would greatly shorten the fallow period or possibly dispense with it, improved cultural implements, weeding and drilling as compared with broadcasting the seed.

PLANTING.

The arduous work of wet padi planting is done almost entirely by women and the actual operation is either done by hand or with the assistance of the simple implement called "kuku kambing" (goat's hoof) (1) which is cleverly designed to obviate the prolonged stooping position which hand-planting necessitates. Men usually assist the women-folk to the extent of conveying bunches of seedlings from the nurseries to the fields, pruning the seedlings to check evaporation and subdividing large clumps of seedlings into lots suitable for handling by the women. The women are expert planters, 6 women being capable of planting an acre a day when using the "kuku kambing" The general uniformity obtained by them in spacing the plants is remarkable.

SPACING.

The spacing of plants varies with the nature of the soil and the depth of water in the fields. In good land where high tillering is constant, it is usual to allow 1.5 to 2 square feet per hill, each hill containing on the average 3 seedlings. Thus, in first class land in Krian the average planting distance was found to be 15 by 17 inches (5) or 1.75 square feet per hill.

In medium soils the spacing distance is reduced to about 14 or 15 inches each way, and in poor soils, the reduction of space is carried further though it is rarely necessary to set hills closer than 10 inches apart in wet-padi cultivation. When the water in the fields is deeper than one foot or fifteen inches it becomes necessary to space the plants somewhat closer than when shallow water is experienced, because deep water inhibits tillering considerably and if very deep, even kills may young seedlings. Thus, deep water diminishes a crop seriously by reducing the average number of tillers per plant.

WEEDING.

Weeding is invariably practised in the cultivation of wet rice, the number of weedings varying from 1 to 3 according to local custom, the fertility of the soil, the depth of water and the disposition of the cultivator. In rich soil one thorough weeding some 6 to 8 weeks after planting is usually sufficient, since the growth of the young rice plants is so rapid that the plants quickly form a heavy canopy under which weeds thrive but slowly and have little effect on the crop. In poor soils, on the contrary, the best results are obtained when the land is weeded twice, since otherwise the growth of weeds tends to overtake that of the rice plants. The stunting effect of shading is quickly noticeable on the latter and in addition tillering is completely inhibited.

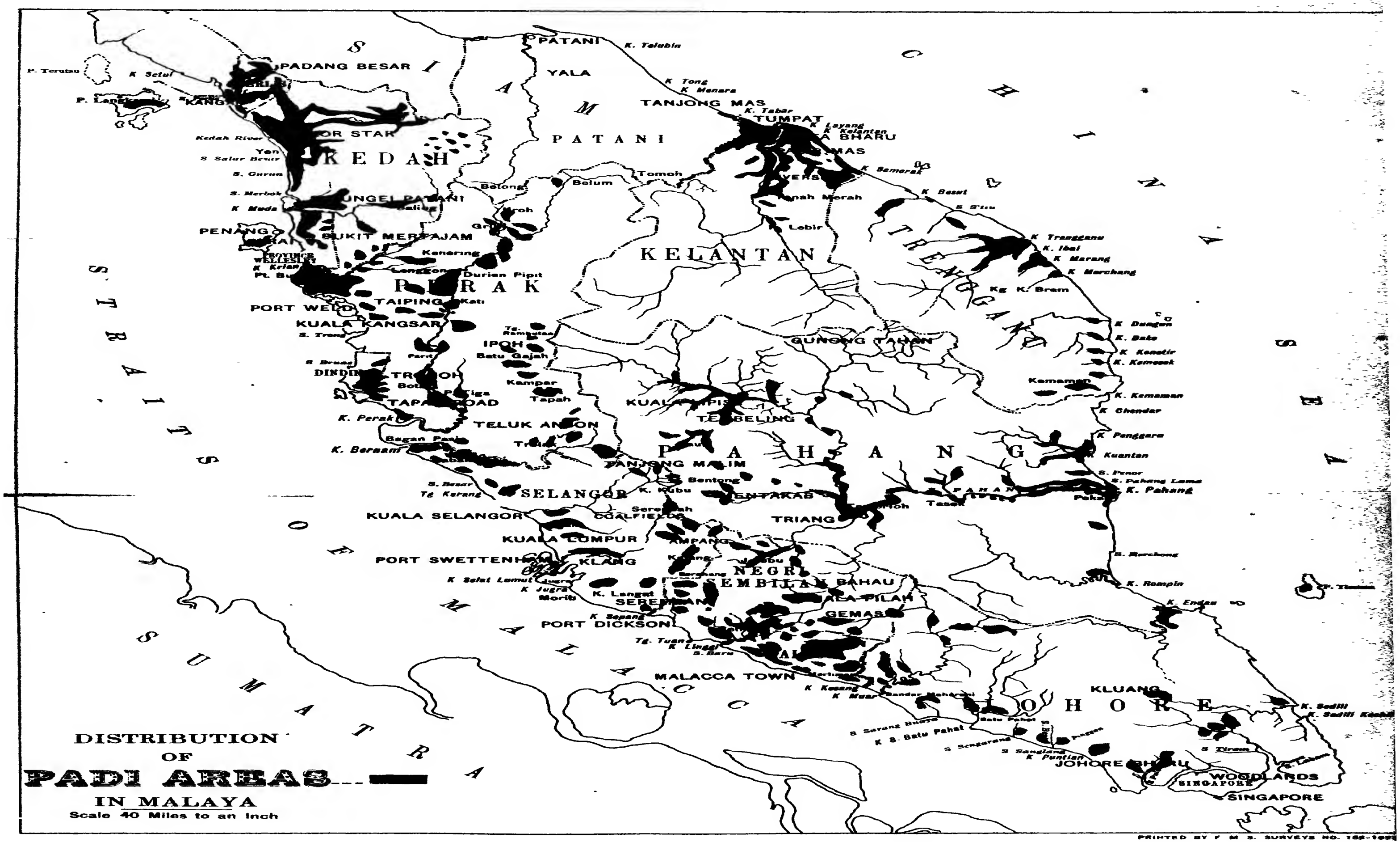
TILLERING.

When the young plants have been firmly established in the field for about a month they begin to tiller, that is, each plant sends up a varying number of shoots from its base, each shoot eventually forming a flowering head (ear) and bearing fruit. It has been shown (5) that the number of tillers per plant within a variety depends on the fertility of the soil, the distance of planting and the depth of water in the fields so that the economic planting distance varies in different localities according to soil conditions. Under the best possible conditions, a good variety such as 'Seraup' (8 months) may produce as many as 50 tillers per plant, but under good ordinary agricultural conditions, 18-20 tillers per plant is a good average, while in poor soil 2-3 tillers per plant are frequently found. This ability of rice plants to tiller is often useful in breeding work when it becomes necessary to supply vacancies in a planted area of definite dimensions, for the plants can be divided several times without any apparent damage being done to the stock plant, which quickly throws out fresh tillers to replace these excised. Thus a ready method of bud propagation is available at any time should an increase of the planted area of any particular strain be required. This method of propagation has already proved useful in experimental work.

FLOWERING.

The time which elapses between the planting of the seedlings in the field and the appearance of the flowers varies with different varieties. In Malayan rice, this may vary from 2 to 6 months. The first indication of the flowering period is a pronounced swelling of the stem of the leading shoot, shortly after, the young colourless flowering panicle thrusts itself through the ensheathing leaves, the individual flowers beginning to open about 10 days later. The flowers mature from the top of the spike downwards, a period of about 6 days being necessary to ripen all the flowers on each panicle and each flower only remains open for some 20 minutes. Self-pollination is usually effected before or during the opening of each flower, (5).

1. Observations on the Technique required in Field Experiments with Rice—H. W. Jack—Bulletin 32, Department of Agriculture, F.M.S. and S.S., 1921.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PATANI
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TANJONG MAS
TUMPAT
PENANG
BUKIT MERTAJAM
TAIPING
PORT WELD
KUALA KANGSAR
IPOH
DINDING
TELUK ANSON
KUALA SELANGOR
KUALA LUMPUR
PORT SWETTENHAM
KLANG
PORT DICKSON
MALACCA TOWN
GEMAS
TRIANG
KLUANG
WOODLANDS
SINGAPORE

2. The Effect of Partial Sterilization of Soil on the Production of Plant Food -Russell and Hutchinson -Journal Agricultural Science, Vol. 3, Part 2, 1909.

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(To be continued).

*REPORT ON "BLACK FRUIT" DISEASE OF PEPPER VINES IN SARAWAK.

By A. Sharples.

A visit to Kuching was arranged on a request from His Highness the Rajah of Sarawak for the "services of a Mycologist to advise as to the best means of dealing with a disease which threatens to destroy the pepper gardens of the country." I arrived in Kuching on 19-9-22, and immediate arrangements were made for me to visit diseased pepper gardens in the district easiest of access from Kuching.

General data.

A few details regarding the general aspects of the pepper industry to-day and in the past will be of importance in connection with my later remarks. In his first letter on this subject H.H. the Rajah says. "As you are probably aware the pepper industry has always been one of the mainstays of the State, but within the past fifteen years production has seriously decreased owing to a disease the origin of which, and the remedies necessary to eradicate it, are beyond the knowledge of the local planters."

This statement cannot be described as exaggerated when the true position is realised. The following figures are of considerable interest.

Year.	Quantity Exported.	Value.
1877	30 piculs	$ 358
1880	350 „	3,850
1885	6,578 „	121,997
1890	16,834 „	237,476
1901	37,016 „	1,417,499
1902	47,122 „	2,205,762
1903	59,342 „	2,733,301
1904	63,616 „	2,611,478
1905	74,584 „	2,638,414
1906	90,177 „	2,394,278
1910	61,408 „	1,531,246
1920	18,031 „	712,122

The table shows that pepper planting was first seriously taken up between 1880 and 1885. Direct Government encouragement was primarily responsible for the large relative increases in area brought under pepper cultivation between 1880 and 1890.

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* Published by kind permission of the Sarawak Government.

The terms of this proclamation were published in 1876 and one clause was "Free passages to Planters and Coolies from Singapore." It is probable that this proclamation was directly induced by the successful cultivation in Singapore and with the failure of the pepper industry in Singapore about 1896 the benefits derived from the forward policy adopted by the Sarawak administration is directly reflected in the figures given which show the tremendous increase in value between 1890–1901.

The position is succinctly stated by a local gentleman, "When the bubble burst in 1906, (in Sarawak), many planters were ruined, gardens were abandoned and disease became rife through the plantations. The disease of "Black Berries" is to-day mainly responsible for the rapid decline of exports; it is considered incurable *but nothing has been done to stop its spread.*"

Reasons for failure in Singapore.

Ridley (1) gives many interesting details regarding the cultivation of Pepper, but the failure in Singapore of Pepper cultivation is the only item of immediate importance in connection with my observations in Sarawak. I quote from page 293 of (1) "In Singapore pepper cultivation seems to have been started by an energetic Chinaman in 1825 ....The cultivation soon increased and continued a prominent feature of the country till about 1896, when partly from the low price; and partly from the exhaustion of firewood for cooking the gambir (pepper cultivation was usually combined with gambir cultivation) and making burnt earth for the pepper, and also of suitable timber for pepper posts, both the gambir and pepper plantations dwindled away, and in 1906 hardly one was left. During this period the area under pepper and gambir was very large and almost the whole of the original forest of the island was destroyed to make way for the two plants. After the abandonment of the ground, it became covered with lallang grass, and eventually with secondary scrub, *and was valueless for many years*."

Ridley does not record any disease which was of importance in accelerating the failure of the crop in Singapore.

Botanical General Information.

A few notes are necessary as to the main Botanical features of the Pepper Vines. Ridley records many varieties under cultivation but in the wild state the true pepper *Piper Nigrum* L. is a woody climber attaining a considerable length. The stem is flexuous and at the nodes, numerous short roots are produced by means of which the vine clings to its support. In the wild forms it is stated that the plant is unisexual, having only male flowers or female flowers on each vine, but in the cultivated forms the spikes are usually hermaphrodite, having male elements (stamens, which contain the pollen) alongside the female elements (pistil). The presence and abundance

1 Ridley, H N.—Spices—1912. Macmillan & Co., Ltd

of stamens in the flowering spikes is of the utmost importance to the planter, for if the supply of pollen is not sufficient the spikes will be partly sterile and the crop of pepper small.

Remarks on Cultivation in Sarawak.

During my visit of inspection in Sarawak I saw little to support Ridley's paragraph on Page 254 as follows: —"The necessity for protecting roots in the open fields against excessive sun heat by covering the ground with cut grass, or the refuse gambir leaves, and the healthier appearance of vines grown under light shade, among fruit trees and the like, also evidence the fact that pepper does not like continuous and excessive heat and dryness." No shade was used in any of the gardens I saw in Sarawak except where rubber had been interplanted and in these cases both the rubber and pepper were usually poor. The young gardens I inspected showed no signs of having had their roots shaded from the sun by leaf refuse though the young cuttings require shade until they commence to shoot. Similar results might be brought about, however, by the early mounding of earth over the roots, and the local atmospheric conditions might render shade treatment unnecessary.

Use of burnt earth in pepper gardens.

To one previously unacquainted with pepper cultivation the system of burning earth and using this continuously to refresh the soil around the vines is a striking feature. Low scrub, bushes, boughs of trees are cut and partly dried in the sun. A quantity is laid on the ground and covered with soil, adding alternately more branches and more soil until a good sized pile is made. The wood is ignited and allowed to smoulder for some days or even weeks, until the vegetable matter is charred. After cooling it is applied to the vines, 3 times a year, until the plant is in bearing--about 2 years old.

The results obtained by adopting this procedure are usually explained by the exceptional response made by the pepper vines to potash salts, derived from the burnt vegetation. It is probable that partial sterilisation (as showed by Russell and his co-workers) of the soil by heating may be of considerable importance. However, in Sarawak, the use of burnt earth is of primary importance, for the local Chinese cultivator leaves his pepper garden when the supply of wood for burning earth is finished; further, land otherwise suitable for pepper growing, is not utilised if there is not a suitable and convenient jungle reserve from which to obtain wood for burning.

These lengthy preliminary remarks are necessary for these will have to be considered when dealing with measures to be adopted in order to place pepper cultivation in Sarawak on its feet again.

Visits to Pepper gardens around Bau.

I reached Kuching on 19-9-22 and arrangements were made for me by the O.A.G. to visit the pepper gardens around Bau, some 25 miles from Kuching. With the energetic help of the D.O., I made visits to several gardens around Bau.

Cause.

The first garden we visited on the Jambusan Poak Road was badly diseased. The pepper vines were fruiting freely, but many of the individual spikes bore only mummified berries. Earlier stages showed small, black spots on practically ripe, mature fruits; these black spots showed the presence of golden-yellow tufts typical of the parasitic Alga—*Cephaleuros mycoidea* (Karstem), with which organism I was well acquainted as a result of investigating its effect on Rubber and Keruing (Dipterocarpus sp.). This organism has been long known as the cause of a serious disease on Tea and also on Clove plantations.

I judged that this organism was of prime importance in initiating the "Black Fruit" disease on Pepper, but maintained an open mind as to the possibility of other destructive agencies completing the work. However, work on completely mummified berries, strongly supported the view that *Cephaleurous mycoidea* (Kars) is responsible for the whole of the symptoms observed.

C. Mycoidea on other hosts.

This algae is of interest as being, in the opinion of competent observers, the most serious blight caused by cryptogams (non-flowering plants), to which Tea is subject in N E. India. The symptoms observed on Tea are usually described under the common name of "Red Rust"

The alga is widely distributed throughout tropical Asia, Africa and America, and is found on numerous host plants.

Butler (1) says "In the Calcutta Botanic Gardens alone, it has been found on twenty species belonging to the most diverse families, from ferns to forest trees and garden flowers. A complete list of hosts in India would probably exceed a hundred and it is somewhat remarkable that, so far (in India) only one other plant of economic importance, the mango, has been found to suffer from its attack in this country." He further records that Liberian coffee is, however, sometimes injured by a very similar or even identical Alga in Java and elsewhere and it has been recently found attacking cacao twigs in the Belgian Congo, producing a serious disease of the same type as that in Tea.

C. Mycoidea on Cloves.

Ridley (loc cit) says that this Alga is a very troublesome and destructive pest on cloves, and that it is known as a destructive parasite on many kinds of thick-leaved trees in the Straits Settlements, Malay Islands, and Ceylon. It attacks among other trees, Camellias and Mangosteens. A record of some interest is that of a clove tree growing under a large Para rubber tree that was but little damaged, though the parasite was present. Ridley puts forward the view with reference to cloves, *i.e.* "I am inclined to think that the actual shading of the tree has more to do with the check of the pest, as young seedlings planted under shade in lines in a wood partly cleared for the clove plant seen quite free from the disease."

Method of attack of C. Mycoidea on Tea as compared with Pepper.

On many plants on which *C. Mycoidea* has been found, it occurs as a simple epiphyte, growing on the surface only and not penetrating the leaf tissues. This is well exemplified on Rubber. Not infrequently, however, the present species penetrates the leaf cuticle, and in some penetrates the whole tissue. The form on coffee in Java occurs on the young berries as well as the leaves, some of the filaments penetrating the tissues of the fruit, though the majority remain superficial. Finally in its most serious form, the alga attacks the young woody shoots, which become cankered and are killed. It is only in this form that it is really a destructive parasite, tea and mango being the most completely studied cases, though the stems of other plants, are not infrequently attacked.

My visit to Sarawak provided the first record of *C. mycoidea* (or closely allied species) as the cause of a serious disease on Pepper Vines cultivation. My observations indicate considerable differences as between its mode of attack on Tea, etc. and Pepper. As my visit was not of long duration, I am not prepared to try to explain these differences but on Pepper Vines, the disease is almost purely a fruit disease; it is difficult to find any trace of *C. mycoidea* on young vigorous vines up to time of flowering, 1½--2 years. The Alga is seldom found on the leaves or stems of vigorous plants although the fruits may be badly affected--the only record I made, after considerable search, was to find the leaf stalks attacked on Vines growing under slight shade provided by Rubber trees.

Symptoms.

The fruiting spikes set normally, but after a time the berries at the free end turn black, shrivel and some fall off. At this stage, the remainder of the practically ripe berries, will show small black spots, which under a hand-lens, show minute golden tufts, typical of *Cephaleuros mycoidea*. These appear superficial at this stage, but the disease progresses, and berries about the middle of the spike shrivel and turn black. In the final stages the whole of the berries on the spike become involved; most fall to the ground, but usually a few mummified berries still remain attached to the blackened spike.

Previous work on this disease-causing organism led me to consider the probability of a secondary organism getting in through the superficial lesions caused in the early stages by *C. Mycoidea*, and completing the work of mummification. Specimens were taken down to Kuching for observation in the laboratory. The only result of culturing completely mummified berries was to obtain beautiful growths of this Alga--the results were so striking as to suggest that the mummified berries could be considered as Sclerotia of *C. mycoidea*. The formation of such bodies would add difficulty to the question of

control, for it would enable the organism to persist in time, for a much longer period and would involve the collection of all such diseased berries.

The final result is not only a large absolute loss of crop but also a large loss of the more valuable white pepper. The internal part of diseased berries even when they remain on the spike are blackened throughout and are useless for white pepper production.

CONTROL.

Previous investigations do not aid much in pointing the way to control methods, as in no case can the action of the parasite on other hosts be compared with its work on pepper vines. There is only one record I have been able to find regarding *C. mycoidea* causing a fruit disease, *i.e.* on Liberian coffee, and I cannot obtain information regarding methods of control on this crop.

As stated in my preliminary report two main lines are open.

(a) Spraying methods.

(b) General Agricultural Organisation with a possibility of a combination of *(a)* and *(b)*.

REMARKS ON SPRAYING METHODS.

In my first report I stated that I viewed spraying methods with some reluctance. This attitude I adopted more firmly after I visited Bau to carry out preliminary spraying trials. All the present conditions in Sarawak are against successful spraying. The pepper gardens are small in extent and fairly widely separated and there is no easy communication. A clean water supply is essential for the mixing of the usual spraying mixtures, otherwise the nozzles, which must have an exceedingly small opening to be effective are constantly choked. This results in considerable loss of time and materials. Moreover the difficulty of making up Copper or Lime-Sulphur sprays renders their recommendation unadvisable under the existing conditions.

As matters stand the only hope for spraying is to utilise some of the patent proprietary Coal-Tar fungicides, soluble in water. In my preliminary experiments I used "Agrisol" in 2½% solution. This solution sprayed quickly and effectively without choking the nozzle; its fungicidal action, however, is still to be tested. Other proprietary fungicides, miscible in water, such as Izal, Brunolinum Plantarium might be tried experimentally on a small scale. Any spraying operation such as recommended above, should be carried out with discretion, as there is some possibility of severe damage to the vines, if the mixture is not suitable.

AGRICULTURAL ORGANISATION.

It is obvious that spraying measures cannot be recommended even experimentally without reservation. With a properly qualified

Agricultural expert to supervise, spraying experiments might be devised and results obtained which would help the general control to a considerable extent. Thus the position at present can only be improved by setting up machinery to initiate Agricultural organisation, with a view to accelerating general sanitation in the agricultural pursuits of the country.

I might say at this point that local experience might considerably influence recommendations as regards organisation. As my visit was only of short duration the following remarks, therefore, can only be regarded as suggestive; local conditions may render imperative the need for modification. The main lines I recommend will, however, be clear enough.

Healthy appearance of young vigorous vines.

In connection with the "Black Fruit" disease, a striking feature is the absence of *C. mycoidea*, up to the time of the flowering spikes appearing, some 18 months—2 years. A case was observed however, where in a pepper garden vines 5 years old, showed no signs of flowering and were less developed than those in a neighbouring garden of 18 months. This backward garden might be a case of degenerate stock owing to continued planting from cuttings, but this degeneracy of stocks has little to do with the "Black Fruit" disease, for the berries on the finest looking vines are as badly affected as those on a badly grown vine. Thus the question of degenerate stock can be held in abeyance which aids considerably in the consideration of immediate control.

Attention has already been drawn to the question of forest reserve influencing the position and tenure of pepper gardens. Once the supply of wood for burning earth is finished the pepper planter must migrate to a fresh area, leaving his probably, badly infected garden just as it stands. This is the first step to be considered. Is the pepper planter forced to migrate, or cannot some method be adopted by which he could remain permanently in one spot? If no measures can be introduced to keep the land given out for pepper under permanent cultivation, and migration is enforced by lack of supplies of timber for burning, all the pepper vines, and posts should be uprooted, the vines burnt and the *belian* poles if still usable should be well disinfected and transferred. It may be cheaper and more convenient of course, to add the poles to the bonfire.

Thus when land is given out for pepper cultivation, a clause for destruction of all old vines etc. in the case of the site being abandoned, should be enforced under strict penalty. As the gardens are usually small, such a clause would not entail and hardship.

The limiting factor for the pepper gardens is wood for burnt earth. As the forest reserve is denuded of its wood could not some quick growing tree, suitable for fuel be planted and the reserve thus restocked with wood grown specially for burning purposes? The Conservator of Forests, would probably be much interested in this proposition. I suggest as suitable trees for experiment, *Grevillea*

robusta, Albizzia moluccana, Cassia Siamea, Michelia Champaca. I am fairly confident that something in this line can be done and thus not only prevent the abandonment of pepper gardens and this land becoming useless, but prevent waste of large areas of forest land. I think this would prove the most profitable line in the immediate control of "Black Fruit" disease, for if careful site selection were undertaken at the inception of a pepper garden, so that a fairly clean water supply was at hand spraying measures would possibly be undertaken with success. The immediate benefit would be in stopping the exodus from gardens on immaterial grounds and a consequent large reduction in the number of gardens abandoned. It is these abandoned gardens which act as centres of infection and as long as present methods are in vogue new gardens will certainly become infected. Could the wood supplies be made permanent along some such line as suggested, the control of "Black Fruit" disease is practically ensured. Healthy pepper vines produce profitably for 12—14 years (according to my information) and there seems no reason why the land should be abandoned when the vines need renewal, more especially as the soil is continually refreshed by applications of burnt earth. With a permanent area of artificially restocked jungle for burning purposes, situated conveniently, land once given out for pepper growing should remain under permanent or almost permanent cultivation.

Question of abandoned Rubber.

Abandoned rubber holdings are only too noticable in Sarawak. The presence of abandoned rubber is of importance because *C. mucoidea* is epiphytic on rubber leaves, more especially on rubber trees under bad conditions of cultivation. The question of abandoned rubber will have to be considered in general sanitation measures, for such will act as centres of infection just as efficiently as abandoned pepper gardens.

The problem presented in Sarawak could only be effectually dealt with by experts on the spot, and although I have gone to some length to indicate lines of quickest progress, every stage will have to be studied carefully.

I do not think it advisable to go into greater detail, as for instance to give formulas for spraying mixtures, for I do not consider for a moment that a non-technical officer could possibly appreciate the difficulties inherent in all disease control. To put effective measures into operation the appointment of agricultural officers is a necessity. I would suggest a Chief Agricultural Officer or Director with special knowledge of disease research be appointed as soon as possible to be supplemented later by the appointment of an Assistant Chemist. Two officers of good experience should be able to tackle the pepper disease and reduce losses to negligible proportions, unless prolonged experience of "Black Fruit" disease on pepper, shows complications which I did not appreciate during my short visit. Personally I do not except any complications which would render it necessary for me to modify my opinion—that "Black Fruit" disease on pepper could be reduced, *not eradicated*, to negligible proportions. Care would always be necessary, but only in cases of neglect is there reason to expect serious loss.

The appointment of two Agricultural officers as suggested would result in much improvement in other directions. The agricultural pursuits noted on my visit, padi, coconuts, rubber, would all be improved by expert advice and much improvement might be expected in those crops.

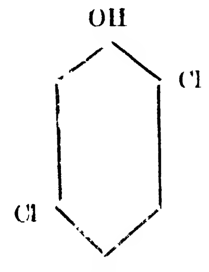
In conclusion, I must record my indebtness to the Resident Kuching, Mr. A. B. Ward for his endeavours to accelerate all my requests during my visit. To Mr. F. H. Kortright, District Officer, Upper Sarawak I offer my appreciation of his hospitality and it is largely owing to his keen and energetic direction that I was enabled to see as much as I did during a limited stay.

DICHLORHYDROQUINONE AS A PREVENTATIVE OF SPOT DISEASE ON RUBBER.

By R. O. Bishop and V. R. Greenstreet.

A sample of a chemical reputed to be a preventative of spot disease on rubber was received from Mr. Edwards M.C., Chemist to the Rubber Growers' Association Malaya for examination.

It was identified as the sodium salt of one of the dichlorhydroquinones probably a commercial form of the 2:5 symmetrical compound : —



Experimental: —Experiments to prove its efficacy were subsequently carried out. A four per cent aqueous solution was prepared and samples of rubber treated with it in the following manner. Each sample was prepared from three quarters of a gallon of bulked latex and coagulated with three ounces of a 5 per cent acetic acid solution.

In the first experiment the solution of the chemical was added to the latex and crepe and slab rubber were prepared from the coagulum. In the case of the slab, this was allowed to mature for one week before creping. After creping and drying all the samples were dipped in water, rolled up loosely and stored for three months, after which they were dried before mixing, preparatory to vulcanisation.

In a second experiment the samples of crepe were soaked in the solution of the chemical for 6 hours, after which they were dried at 50°C. The samples were then spotted with water, rolled loosely and stored in a dry cupboard for three months.

Control samples of slab and crepe were prepared and treated in the same manner, except that they were not treated with the chemical.

The following table gives the results obtained : —

EXPERIMENT I.

Sample No.	Ref No.	Type of Rubber.	Treatment.	Results.
1	192Ac	Crepe	Control	Very mouldy
2	192Ec	Crepe	0.5 per cent solution of chemical added	Traces of mould
3	192Bc	Crepe	1 per cent solution of chemical added	No mould

Sample No.	Ref No.	Type of Rubber.	Treatment.	Results.
4	192As	Slab	Control	Mouldy
5	192Es	Slab	0.5 per cent solution of chemical added	No mould
6	192Bs	Slab	1 per cent solution of chemical added	No mould

EXPERIMENT II.

Sample No.	Ref No.	Type of Rubber.	Treatment.	Results.
7	192Cs	Slab	Control dry	No mould
8	192Cc	Crepe	Control dry	Mouldy
9	192Dc	Crepe	Control spotted with water	Very Mouldy
10	192Dco	Crepe	Soaked in solution of chemical then spotted with water	Mouldy
11	192X	Bark Scrap crepe	Control spotted with water	Mouldy
12	192V	Bark Scrap crepe	Soaked in solution of chemical then spotted with water	No mould

The samples of rubber were then vulcanised, using a mixing of 90 parts of rubber to 10 parts of sulphur with the result shown in the table below :—

No.	Type of Rubber.	Optimum time of cure from tensile curve. (minutes)	Optimum time of cure giving maximum tensile strength (minutes)	Breaking load (kilos per sq. mm) (a)	Elongation at break (original length = 100) (b)	Tensile product (a × b)
1	Crepe	150	120	1.06	1065	1128
2	Crepe	150	150	1.31	1025	1342
3	Crepe	150	120	0.86	1000	860
4	Slab	80	75	1.38	1045	1442
5	Slab	80	70	1.42	1091	1549
6	Slab	80	75	1.12	1016	1137
7	Slab	80	75	1.28	1030	1318
8	Crepe	150	120	1.01	1027	1037
9	Crepe	180	180	0.98	1025	1007
10	Crepe	180	180	1.02	978	997
11	Bark Crepe	165	165	0.85	923	784
12	Bark Crepe	165	165	0.83	885	734

Remarks and conclusions :—These results show that dichlorhydroquinone is efficacious in preventing the formation of mould in crepe rubber. An amount equivalent to 35 cubic centimetres of a 4 per cent solution on three quarters of a gallon of latex containing 15 per cent of rubber is sufficient, when added to the latex direct. This is equivalent approximately to 0.27 per cent of sodium dichlorhydroquinone on the dry rubber or about 6 ozs of the pure chemical per 100 gallons of latex containing 1½ lbs. of rubber per gallon. By soaking crepe rubber in the solution, mould growth is not prevented to the same extent, although it may be retarded. The amount of antiseptic necessary to prevent mould growth does not interfere with the normal maturation of slab rubber. These small quantities of the chemical do not appear to affect either the tensile properties or the rate of vulcanisation of the rubber. It is understood that a similar substance is on the market under the name of "Mouldicide."

Received for publication May 1th, 1923

OIL CAKES.

As Feeding-Stuffs for Cattle.

THE following is an abstract of information contained in a report presented at the Congress of Colonial Production by Professor Dechambre and published in Bulletin des Matieres Grasses de l'Institute Colonial de Marseille (Nos, 11 & 12, 1922). Emphasis is laid on the value of oil cakes as cattle food which is well known to French cattle breeders. Attention is drawn to the economic advantages gained by the use of oil cakes and the results obtained. The value of oil cakes in increasing the yields of individual animals in respect of production of milk, meat or of work is also pointed out.

All farm animals including young, stock for breeding purposes, cattle for milk or fattening, draught animals and poultry can be fed on oil cakes as a supplementary diet.

In order to obtain the most satisfactory results, it is necessary however to work out carefully for each type of animal, the kind of cake most suited to its requirements, its preparation and the amount of ration. The satisfactory feeding of and the provision of a liberal diet to the mother during the period of gestation is of considerable influence on the development of the young and ensures an abundant secretion of milk. The rate of development of the young animal is also influenced considerably by the diet provided after the suckling period.

Experiments on pigs, which respond well to the influence of a proper diet furnish valuable data. Figures are quoted in support of this statement.

Defects due to poor early development owing to bad feeding also persist at a later stage of growth. Oil cakes are extremely useful, as they enable the farmer to provide his breeding stock animals with a complete diet.

Experiments on calves carried out by the Department of Agriculture Areige have demonstrated the value of copra cake as a feeding stuff at the time of weaning and subsequently.

Trials with young pigs fed in the usual way on Sorghum show that groundnut cakes, provided in the proportion of 20 per cent of the weight of the Sorghum ration, enabled the pigs to get over the weaning period without any check in growth or organic development.

A suitable daily ration consisted of Sorghum 1200 grams (2.6 lbs.) bran –400 grams (0.9 lb.) and groundnut cake 300 grams (0.7 lb.), given in three meals.

Oil cakes are also invaluable during a scarcity of food stuffs and during hard times to prevent forced sales at falling prices.

Cows can be maintained by means of a ration of straw or coarse forage together with oil cake. The straw should be cut up and macerated with the oil cake to form a suitable mash. Beneficial results have been obtained by using a mixture of maize and oil cake as a ration for cows in milk.

As a result of experiments by the Director of Agriculture, Gironde, on pigs, it has been shewn that it is possible economically to raise the weight of pigs with a diet of water, groundnut cake and palm kernel cake.

Oil cakes alone or mixed with other foods can also be used for poultry feeding. Palm kernel cake is suitable for breeding or fattening purposes. The following formula is recommended for laying birds :—

Fish meal 20 parts, mashed nettles 20 parts, crushed oyster shells 7 parts, small grit 3 parts, ground nut cake 30 parts and palm kernel cake 20 parts. The nettles are cut up finely and soaked, before being mixed with the other ingredients.

Copra cake has given good results with rabbits and is equally suitable for fattening ducks, geese, turkeys and fowls. It imparts no objectionable taste to the flesh.

The above information and many other experiments have thoroughly demonstrated the value of oil cakes as a feeding-stuff. In Malaya, both copra cake and ground nut cake are available but, owing to the comparatively small number of cattle, poultry and pigs, most of the cake is exported from the country.

An investigation of local feed-stuffs for poultry is being carried out by the Chemical Division of the Department of Agriculture.

B. J. E.

Received for publication March 12th 1933.

CANDLE NUT OIL

FROM ALEURITES MOLUCCANA.

THE following information in respect of markets for Candle nut oil has been received as a result of enquiries made by the Department.

(1) Large quantities of Chinese Wood oil are sold in England for paint and varnish manufacture. The bulk of the Hankow oil is from *Aleurites Fordii* while that from Canton is chiefly from *A. Montana.*

The oil from the Japanese variety, *Aleurites Cordata*, is also found on the market. The principal property of these oils is that they polymerise and form suitable films when treated by certain methods and their value in paint and varnish manufacture is due largely to this property.

Candle nut oil from *A. Moluccana*, although closely related to Chinese Wood oil does not polymerise in this way and is therefore not suitable as a substitute. It can however be used in paint and varnish manufacture, but there appears to be no definite market in England for large quantities. This however is probably due to the fact that hitherto large quantities have not been available regularly and buyers will not go to the trouble of experimenting with small lots or fix contracts binding them to take an oil which has not a definite market value.

The oil cake cannot be used for cattle feeding and it is therefore preferable to export oil rather than kernels. In any case the export of the whole nut is not economical on account of freight charges. A large firm of oil mill machinery manufacturers in England states that there should be no difficulty in disposing of any quantity of the oil. Hitherto the oil has not been used to any appreciable extent and the successful marketing of the oil will depend to a considerable extent on the price at which the oil can be sold.

Firms to whom enquiries were addressed however require samples for trial and suggest that a consignment of about a ton be placed on the market. One firm considers that it will probably not be a practicable proposition to shell the nuts and export the kernels and that it will probably be preferable to express the seeds on the spot.

Further, if the kernels are broken during shelling the quality of the oil may be deteriorated.

The Director of the Imperial Institute considers, as a result of enquiries, that the oil would probably realise about two-thirds the price of linseed oil, which is at present (March 1923) about £40/ per ton. The dry kernels should realise about three-quarters the

price of linseed. The principal market at present is in America, which imports the oil from the Philippines under the name of "lumbang" oil.

In 1918, 184 tons of the oil valued at $65,000/- gold were shipped from the Philippines and a much larger quantity could be absorbed by the American market. The shipping of whole nuts would not be remunerative but the export of the kernels might be profitable.

The Director of the Bureau of Science, Manila has been good enough to supply the following information :—

" Lumbang oil is one of the many vegetable oils found ordinarily
" in the U.S. markets. Quotations of prices are given in " Oil, Paint
" and Dry Reporter," 100 William Street, New York. In May—
" June, 1922 the price was $0.10—$0.105 per lb. The oil is ex-
" pressed locally, partly for export, but mostly for home consumption.
" Nuts or kernels are not exported, but could be handled like copra.
" The tree grows abundantly in the wild state in the Philippines and
" the Government is encouraging the planting of the tree, but there
" are no large plantations yet."

B.J.E.

Received for publication 17th April 1923.

RESUME OF AN ADDRESS MADE BY MR. A. CAVENDISH,

Officer in Charge of Co-Operative Societies at the Conference of the Malay Officers* of the Agricultural and Co-Operative Departments held on Monday November 20th, 1922, at Kuala Lumpur.

THE Conference marked a new stage in the development of Agriculture in this country in so far as it was the first appearance of the Officers of the Co-operative Department. Mr. Cavendish emphasised the necessity of the very closest co-operation between the Officers of the Agricultural Department and those of the Co-operative Department. The work of the Agricultural Department was directed rather towards the scientific and technical side of agriculture whereas the Co-operative Department was concerned more with the economic side. Hitherto practically no attention had been paid to the economic side. He quoted the words of Sir Leslie Scott, Chairman of the Agricultural Organisation Society in England which bear upon the present position in Malaya, and which he varied to suit the local conditions:--

> "Planters do not plant for patriotism or for fun; they plant to make a living for themselves and their families........ ....It is no use to preach to planters how they should plant unless you can tell them at the same time how they can plant at a profit."

The need for closer co-operation of the work of the Agricultural and Co-operative Departments and the necessity to investigate thoroughly the economic side of agriculture was also brought out in certain passages from Mr. Cavendish's report of August 1921 giving a brief account of the system of Co-operation in Burma with certain recommendations for introducing the system of Co-operation into Malaya, and Mr. Eaton's report on Agriculture for the year 1921 published in 1922. The following extracts from his reports on co-operation was quoted :—

(i) "The Agricultural Department should cover a much wider field of operations than it has done in the past. It should use the service of co-operative societies for the dissemination of agricultural improvements, the supply of seed of purer strain or of improved varieties and the introduction of improved machinery and implements; and generally assist the co-operative purchase and sale of agricultural supplies and products of societies. The advice and assistance of the Agricultural Department should be readily available for such work as the grading and marketing of produce of agricultural societies where expert opinion is essential. The societies should not, however, be used for experimenting in new processes but for popularising proved improvements. Periodical conferences arranged by the Agricultural and Co-operative

*(Many European Officers were also present)

Departments should be held—possibly and preferably whenever agricultural shows take place in different places."

Mr. Eaton in his report wrote :—

(ii) "Another desirable function of a Department of Agriculture which has not received due attention in the past, chiefly owing to lack of staff, is the question of agricultural economics, in respect of markets, co-operation among small holders for transport facilities or local purchase of produce for export, and machinery for the treatment of certain crops for the market. The proposed formation of Co-operative Societies working in conjunction with the department should be of considerable value in this connection.

"At present information is available on many crops which can be grown in Malaya, but unfortunately is lacking in respect of costs of production, including cost of planting, cultivating and harvesting and preparation for the market. These factors which must be known in estimating the probable profits to be derived from any crops are receiving attention in connection with the cultivation of new crops at the Experimental Plantations, Serdang.

"It is not possible nor desirable for the Department, except to a limited extent, to become purchasers of produce, but it should be able to render useful assistance by placing producers in touch with probable buyers and keeping in touch with the market value of agricultural products.

"Lack of staff in the past and the lack of any suitable large scale plantation, which has resulted in the dissipation of energy on a number of small and unsuitable experimental plantations, has resulted in absence of knowledge of the local possibilities of crops other than rubber, coconuts and rice and a few other crops. The possibilities of any new crop can be determined only by suitable field trials carried out in many cases over several seasons in the case of annual or semi-permanent crops, owing to the number of variable factors concerned."

The development of the scientific and economic sides of Agriculture could not be left entirely to Government or to the efforts of two official departments like the Agricultural and Co-operative Departments. The practical planters must also join in the common task. The task could be most effectively performed by means of an Agricultural Organisation Society composed mainly of leading land owners of every nationality and their representatives assisted by Officials from the Agricultural and Co-operative Departments in a minority as the representatives of Government. The scheme for an Agricultural Organisation Society was more fully set out in a paper entitled "Co-operation as a subject for Study in Malaya."

It would be part of the work of an Agricultural Organisation Society to convene Agricultural and Co-operative Conferences attended not merely by a few officials of Government but also in large numbers by that section of the public interested in Agriculture. Such conferences were held periodically in India in conjunction with Agricultural shows or other big social or commercial functions. For instance the Agricultural and Co-operative Conference in Burma was attended by over 1,000 delegate of co-operative societies. It was opened by the Governor in the presence of Commissioners, Deputy Commissioners and leading officials. The Press, the leading merchants, bankers, shippers, Railway officials, millers and other prominent members of the commercial community were present and took part in the deliberations. After the opening address made by the Governor, speeches were made by the Director of Agriculture, Registrar or Co-operative Societies, Chairman of the Co-operative Bank and others on the leading events which had taken place and on the progress made since the last conference. The conference then broke up into special committees to consider the manifold issues connected with Agriculture. Questions affecting stock breeding, cattle insurance, the development of rural industries such as weaving, pottery, arts and crafts, etc., etc. were discussed and considered. The Director of Museums and Chief Veterinary Officers took part in these deliberations. Mr. Cavendish hoped that such conferences would some day be convened in Malaya and that the Malay Officers would take part in them and would not be content merely with reading papers, but would also be able to get up and express their views during the various discussions. Such conferences were of the greatest educational utility and he trusted that the officers of the Agricultural Department both European and Malay would do their best to assist the formation of an Agricultural Organisation Society which, when created, would be able to bring into being truly representative Agricultural and Co-operative Conferences.

Received for publication April 9th, 1923.

THE

Malayan Agricultural Journal.

Vol. XI. June, 1923. No. 6.

RICE IN MALAYA.

BY

H. W. JACK.

(Continued.)

V. HARVESTING, THRESHING AND WINNOWING.

Harvesting and Threshing:—

ON account of the variations in the seasons in different localities, harvesting operations are generally in progress in some portion of Malaya between the beginning of November and the end of April.

Primitive methods of reaping are practised, machine reapers having only been used experimentally so far. Two-thirds of the Malayan crop, whatever method of cultivation is employed, is cut by women using the "pisau menuai" a peculiar knife set in a wooden base to fit the palm of the hand. This strange knife cuts each ear of padi separately and the straw, having no monetary value, is left standing in the rice fields. The ears of padi so cut are bound together in bunches and usually sun-dried before being threshed. The Malay women are highly skilled in the use of this knife and the rapidity of their work may be gauged by the fact that one woman can cut 80 to 90 "gantangs" of unthreshed padi per day of 7 hours which is equivalent to 40 "gantangs" of clean (threshed and winnowed) padi.

The rate at which Malay women work depends on their own industry and the condition of the crop (erect or lodged). The density of crop appears to make no material difference to the rate of harvesting (i).

When the crop is cut in this way it is threshed by precipitating the bunches of padi ears on to sheets of grass-matting in the field or at the cultivator's dwelling or on to clean baked soil and by treading on them turning them over repeatedly with the feet in a rolling motion, when the resulting friction separates the grain from the ear. Frequently Tamils beat the padi with sticks instead of using their

feet. This method involves more energy but saves the worker's feet. A good Malay can thresh and winnow 80 to 100 gantangs of clean padi per day, though sore feet would prevent him from doing it on several successive days. The use of sticks in threshing by Tamils, though somewhat slower than the use of the feet, can be continued for a longer spell and consequently an equal amount of clean padi per day can be prepared by either method.

The ear stalks and large pieces of straw are separated by hand from the grain which is later cleaned of all chaff, dust or other valueless matter by winnowing processes. Tamils sometimes cut their padi with the "pisau menuai" also, though they prefer to use a simple knife and work less rapidly on the average than a good Malay. Tamil women can cut about 8 sacks of ears, that is about 35 gantangs clean padi, in a day of 8 hours.

In the northern rice districts near the West coast, where Indian immigrant coolies have long been employed, at first on sugar and now on rubber estates, the bulk of the crops is reaped by Tamil contract labour paid in kind, that is, in gantangs of padi. The contract rate varies between 12% and 25% of the cleaned unhusked crop according to its density and its condition at harvest, an average being 15% under good conditions.

The grain together with about 2 feet of straw is cut in armfuls with a short sharp saw-edged sickle ("sabit") the armfuls being laid on the top of the stubble, which is one to two feet high, to dry. The bunches are loosely bound with straw into sheaves which are conveyed singly to the threshing "tong," which simply consists of a large wide tub. Against the inside of the tub and at inclination to its side a ladder with rounds about 4 inches apart is placed and the sheaves are beaten two or three times on this ladder, the shock of the blow causing the grains of padi to drop into the tub, while all scattered grains are directed back to the tub by a conveniently placed screen of "menkuang" (*Pandanus* sp.) matting. Tamil contract includes the winnowing and drying of the grain. Tamils usually work in parties of five or more. A good party can cut and thresh a heavy crop, at the rate of ¾ of an acre per man per day of eight hours.

Frequently it becomes necessary to harvest the crop in rainy weather. In very wet seasons the soil is often covered by 3—12 inches of water or more at the time of reaping. Under these conditions the work of harvesting is greatly retarded because the movements of the reapers are slower by reason of the stickiness of the mud, and varying amounts of the padi may be lodged or submerged thus rendering the cutting operation more laborious than usual. Moreover the ripe heads of padi frequently hang down into the water and thus germination, quickly followed by decay, causes a considerable loss in the crop. Apart from these reasons much ripe grain falls from the ears in handling the padi straw which often becomes flacid and makes handling well nigh impossible besides forcing the reaper to cut his crop ear by ear. In addition to these difficulties showery weather prevents the threshed padi from drying with the result that germination of the grain sets in and heavy losses are sustained, The total loss of

crop in a wet harvest may amount to as much as half the crop anticipated prior to the damage caused by heavy rains and flood.

Threshing can be carried on independently of the weather, in fact, the Tamils like a few showers since the grains appear to become more easily detached from the straw in damp weather, and the Malays who tresh with their feet, maintain that the work is less injurious to the feet if the bunches of padi are wet. Whatever the effects of rain may be on threshing, it is certainly more desirable that there should be dry weather during harvest for all other operations. Dry weather is particularly required if the grain is to be rapidly and thoroughly dried for should drying be prolonged the grain rapidly deteriorates in quality and value.

Winnowing :

After threshing, which operation comprises the hand separation of the straw from grain, the padi when thoroughly dried is winnowed to remove the smaller pieces of broken straw, empty husks, dust etc. The methods of winnowing are simple, but considering the small size of the holdings they are economical and very efficient, In the northern parts of the country, the fairly strong and constant breeze which usually prevails at harvest time from 11 a.m. to 5 p.m. daily is advantageously used to separate the good from the defective and the chaff grain. A deep circular tray-shaped basket about 3 feet in diameter and of open half inch mesh is suspended from the point of contact of three stout bamboos forming a tripod some six feet high. The uncleaned padi is placed on this basket-sieve which is then rocked gently from side to side so that the padi falls through it in a slow steady stream. The wind carries the chaff, dust, straw etc. beyond the matting which is placed below the tripod to receive the good heavy clean grain. The good padi, thus separated from the chaff, is subjected to a further and final separation and cleaning by repeating the process just described and is then measured into sacks ready for purchase by the millers.

In place of using a basket-sieve suspended from a tripod, frequently, a shallow bottomed basket ("niru") tapering at one end and having a rim about an inch high is filled with padi and held aloft in the hands or on the head at an inclination so that the padi runs off slowly and the breeze effects the required separation of good grain from empty husk, dust, etc. Sometimes this basket has a sieve-bottom, which allows dust to pass through but retains the padi grain. The basket is grasped in both hands about waist high, and with a series of smart jerks, the padi is thrown one to two feet upwards, and the wind carries away the chaff and dust, while the good grain falls back to the basket. Very occasionally when the wind is strong a flat wooden shovel is used for winnowing purposes the padi merely being hurled through the breeze from one position to another.

A further method of winnowing with the "niru" depends on dexterity and experience in manœuvring the empty grains, chaff, etc. by gravitation to the tapered end of the "niru" and then ejecting it with

a sharp wrist movement. Women (Malays and Tamils) are exceedingly expert in this method, very little good grain being lost for the finished clean grain rarely contains more than 1% of debris. The padi hand-winnowing machine affords much the quickest native method of winnowing when the crop is perfectly dry. This very efficient machine is said to have been introduced by the Chinese through Siam. In essential it consists of a box in which a fan is rotated by hand to create the necessary draught for separating the grain. The box opens at one end into a passage through which the breeze escapes. The padi to be winnowed is contained in a hopper placed above this passage and stream of padi from the hopper is easily regulated by adjusting a wooden slat. The padi runs through the artificial breeze and is directed into a sack or basket. The chaff, however, is blown through the escape passage and discarded. Two coolies working this machine can winnow 200 gantangs of padi per hour.

1. Harvesting Padi and its conversion into Rice—H. W. Jack—Agr. Bull. F.M.S., Vol. VIII, No. 1., 1920.

VI. CROPS.

Padi crops vary somewhat from season to season, the chief cause of variation being the amount of rainfall and more particularly its distribution. Thus in the Krian district the annual crops which averaged 14,089,590 gantangs of clean unhusked rice for the twelve years 1910 to 1922, varied in quantity as shown below:—

Season.	Yield.	Season.	Yield.
1910-1911	15,292,899	1916-1917	13,602,662
1911-1912	11,211,168	1917-1918	11,948,072
1912-1913	14,698,320	1918-1919	11,340,352
1913-1914	15,130,601	1919-1920	16,083,702
1914-1915	15,646,611	1920-1921	11,158,259
1915-1916	16,056,289	1921-1922	13,906,130

The fluctuation in seasonal yield only refers to variation within a clearly defined area but the variation in yield between different districts in the same season is much more marked. Thus the best yielding wet padi district (Penang) in a good season has been known to produce at the rate of nearly 470 gantangs per acre over an area of 5,000 acres. On areas of about 5,000 acres this yield is approached in the "mukims" of Bagan Tiang, Kuala Kurau, Parit Buntar and Tanjong Piandang in good seasons, but few other areas of this size or larger can produce over 350 gantangs per acre, for instance the yield per acre in Kuala Pilah which is considered a good padi district is only 240 gantangs of padi in a good season.

There are many smaller areas up to 1,000 acres in extent which produce between 250 and 350 gantangs of padi per acre annually, for example, the mukims of Grik, Lenggong, Ulu Jempol, Serting Hilir, Triang Hilir, Slim, Pulau Tiga, Beranang etc., but numerous smaller areas only produce between 80 and 200 gantangs per acre. These great differences in yield may be due to soil variations, to lack of application on the part of the cultivator, to irrigation difficulties, to scarcity of buffaloes, to epidemic disease amongst cultivators, to the ravages of pests, to bad seeds etc., but they combine to show that there is much room for improvement when the average yield for the whole country (wet and dry padi) is only 192 gantangs of clean unhusked rice (1020 lbs.) per acre per annum. Small areas, as a rule, show a low average of production because they are more severely damaged by animal pests. Dry padi crops are mostly derived from small, more or less isolated patches of land, frequently bordered by jungle and consequently pests, particularly pigs, birds and rats destroy a fairly large proportion of each crop, so that yields rarely show as good an an average as in the case of padi. Also dry padi crops are very dependent on rainfall and therefore crops are precarious. Moreover as mentioned in Chapter IV continuous cropping of the same land, tends to reduce successive yields considerably.

Table VI shows the total production of padi (wet and dry) in each State, the rate of production per acre of wet and dry padi and the average yield per head of population.

TABLE VII.

State or Province.	Average area under rice.	Average yield per annum in gantangs.	Average yield per acre in gantangs. WET	DRY	Average yield per head of population in gantangs.
Kedah	174,000	44,001,000	253	165	130
Perlis	31,000	5,340,000	192	162	133
P. Wellesley	33,500	9,310,000	282	151	72
Penang town	—	—	—	—	—
,, country	6,030	2,261,730	370	—	58
Dindings	720	84,000	135	102	7
Perak	119,505	21,173,500	241	121	35
Krian district	55,000	13,869,000	267	90	161
Selangor (K. L. town)	—	—	—	—	—
,, country	18,410	1,424,000	145	57	4.5
Negri Sembilan	30,400	4,602,000	160	187	25
Pahang	30,025	4,223,000	163	104	29
Malacca town	—	—	—	—	—
,, country	27,622	7,712,000	246	—	63
Singapore	—	—	—	—	—
Trengganu	10,800	2,000,000	200	151	130
Kelantan	175,050	32,436,050	193	162	105
Johore	13,200	1,424,000	160	76	5
Total Malaya	669,262	13,991,280	203	110	41

The figures under the second and third columns in table 6 are based in every case on not less than three years' results and in the case of the Federated Malay States the averages are worked out from figures extending over ten years.

As regards Kedah and Perlis the average yields per annum are based on only three seasons' results. One of these seasons, 1920-21, was bad beyond all precedent from the rainfall point of view with the result that large areas were not planted at all and in other areas the crop was not deemed worth harvesting. Probably the normal production of Kedah averages around sixty million gantangs whereas in the table above it is shown as forty-four millions only. Kedah is the largest producing State though the average area under cultivation is slightly less than in Kelantan.

Next to Kedah, Kelantan is the largest producer, though the production per acre is much lower than in the case of Kedah, probably partly due to the vagaries of the rivers for most of the rice fields in Kelantan are situated along the banks of the main river, whereas in Kedah most of the padi fields are part of the enormous flat stretches of coastal land and are not so subject to rapid changes in the water table. 'lso, the more scattered distribution of padi land in Kelantan would tend to expose the crop more to animal pests, than in Kedah where padi areas are more concentrated. Perak, Province Wellesley

and Malacca are the next largest producing states in order of their production, but owing to the large influx of immigrant labourers the amount of padi produced per head of population is insufficient and large imports of rice are necessary each year. Kedah, Perlis, Kelantan and Trengganu States and the Krian district of Perak are the only areas which can be classed as self-supporting. In each of these areas Malay is the predominant element of the population and immigrant labourers are comparatively few in number.

Perlis, Kelantan and Trengganu are little known States and are still undeveloped compared with the Federated Malay States and therefore have not been opened up by industrial pioneers and their complements of immigrant coolies. Kedah, some years ago was a fairly large exporter of padi but the great progress of the rubber industry in the south of the State and the development of transport facilities in the last seven or eight years have drawn capital and hordes of immigrant coolies who now consume practically all the padi produced in that State except in bumper years when there is a small export. The Krian district of Perak is, agriculturally probably the most thriving district in Malaya. It maintains a large Malay population and in addition supports a numerous body of Indian labourers for the District contains some 61910 acres of rubber and coconut estates, but the high production of padi per head of population is entirely due to the irrigation system which the Government maintains for the welfare of the cultivators. Of all padi producing states, Selangor which shows the smallest production per head of population, contains by far the largest number of immigrant coolies in proportion to its area, because it has been the centre of the rubber industry and the seat of Government. Nevertheless, the area under padi cultivation is very small, partly because little good padi land is accessible but also because the Malay population is scattered and has turned to rubber cultivation at the expense of the padi industry.

The District of Kuala Selangor, however, possesses possibilities of enormous development from the point of view of rice production, if only the right type of cultivator can be induced to settle there.

TABLE VIII.

Dry Padi Areas in Malaya.

State or Province.	Area (acres).	Yield in gantangs.	Yield per acre in gantangs.
Perak ...	20,840	2,521,960	121
Selangor ...	3,276	220,774	67
Negri Sembilan ...	422	36,726	87
Pahang ...	5,222	542,293	104
Perlis ...	65	10,500	162
Johore ...	4,567	347,842	76
Kedah ...	3,570	588,081	165
Kelantan ...	250	37,950	162
Trengganu ...	3,303	500,000	151
Province Wellesley ...	1,000	150,813	151
Dindings ...	615	62,266	102
Total Malaya ...	43,130	5,019,205	116

In the above table the figures for the Federated Malay States have been averaged from statistics covering eight years but in all other States the figures represent the averages of three years only. The table discloses the fact that Perak produces approximately 50% of the total amount of dry padi in Malaya. This is probably due to the large number of small villages dotted about Perak and indicates an attempt at self support by villagers to whom wet padi land is not available, for dry padi, as a rule, is only planted where wet padi land is unobtainable or where very fertile new soil can be planted on the hill sides. The large number of "sakai" clearings, doubtless, is also a factor in dry padi production in Perak.

Of the Federated Malay States, Lower Perak district is by far the largest producer of dry padi, its annual average production being 1,025,600 gantangs, though the amount of padi grown on estates in the district in 1917 and 1918 was a considerable factor towards attaining this average. Moreover the padi returns hardly differentiate wet and dry padi with sufficient clearness but still making allowances the district easily holds first place from the point of view of production. Batang Padang and Upper Perak come next in order of production with averages of 406,000 and 342,900 gantangs respectively per annum.

In each of the three districts above mentioned the increase of Malay population has been very rapid in the last decade and these increases greatly stimulated dry padi production. Thus Batang Padang district which shows an increase of 52% in the Malay population in the last decade shows an increase of over 200% in dry padi production in the same period. Unfortunately, in this district the amount of wet padi land put under cultivation shows no appreciable change during the same decade because suitable land is not available, hence the Malays are driven to the less profitable alternative of dry padi production. Similar though less pronounced increases in Malay population and dry padi production are recorded in the districts of Lower and Upper Perak. Kinta and Kuala Lipis are the next largest producers with averages of 317,000 and 314,800 gantangs respectively, with Kuala Kangsar taking sixth place with 214,000 gantangs annually. Larut with an annual average production of 146,000 gantangs, and Pekan with 104,000 gantangs are the only other districts in the Federated Malay States which produce over 100,000 gantangs annually. Kedah, Trengganu and Johore show fairly large annual productions, but the areas fromwhich these are derived are small and scattered. Of these states the Padang Terap district of Kedah is the largest producer with about 100,000 gantangs per annum.

Table IX. shows the chief dry rice producing districts and the variation in area in acres in each year for seven years.

TABLE III.

Area under dry padi in acres—Seasons 1915-1922.

	Upper Perak.	Larut and Matang.	Kuala Kangsar.	Kinta.	Batang Padang	Lower Perak.	Kuala Selangor.	Ulu Selangor	Kuala Lipis.	Pekan.	Padang Trap.	Muar.
1915-16	512	298	370	1152	776	3220	3822	650	2868	1293	600	—
1916-17	826	70	345	191	856	1732	2155	178	2819	1294	1000	—
1917-18	1372	190	769	970	2190	3107	933	196	2502	1220	1400	—
1918-19	1963	442	952	2576	3200	7811	1513	1016	1943	1167	23[illegible]0	1250
1919-20	3421	2928	4258	6745	10194	11607	1515	2138	2789	1506	2960	1980
1920-21	5000	3015	3300	6398	8415	9604	624	2702	2701	2155	3300	15[illegible]0
1921-22	1330	1563	2665	4861	7638	[illegible]	336	2420	2193	803	3201	2476

Variation in the area under dry rice is more marked than in the case of wet rice, because land suitable for dry rice cultivation is more abundant and more rapidly available than for wet rice, hence the area under dry rice is more rapidly influenced by changes in the market price of rice than is the case with wet rice areas. Also dry rice cultivation is possibly more dependent on rainfall than wet rice since the latter is usually grown in localities where percolating water collects, in contrast to the dry rice areas which are more commonly found on sloping land and thus depend chiefly on the precipitation of rain.

VII. NATIVE METHODS OF MILLING.

Unhusked rice is known throughout the greater part of the East as "padi." In Malaya the husked raw rice is termed "bras" whilst when it is cooked is becomes "nasi." The native methods of preparing rice from padi suit the economic conditions of the people for at harvest, scarcity of labour, which is usually keenly felt in all large padi growing districts, renders it impossible to convert all the harvested padi into rice, consequently the padi is stored as such and is milled at leisure according to immediate requirements. Moreover, stored padi is much less subject to grain pests (rice weevil, etc.) than stored rice and further stored rice does not retain its flavour, whereas, stored padi does for quite a long time. After harvest the surplus stock is sold and the household requirement for the year is stored, most commonly in wooden bins, which may be incorporated in the construction of the cultivator's house, or form a sort of separate outhouse. Again they may consist of several large wooden boxes placed underneath the dwelling. In any case precautions are taken to maintain the grain in as dry a conditi n as possible and to keep out rats, birds and poultry.

In the conversion of their padi into rice, the Malays use two types of simple machines. In the commoner type the padi is pounded in an enclosed space, and in the other type, the husks are split by friction between revolving surfaces. The first type is known as the "lesong" and is so well known that it hardly merits description. There are three forms of "lesong" which differ according to the power used to pound the padi. The simplest is the "lesong tangan" or hand power "lesong" which is used by Tamils and Malays alike, and is usually worked by women. This consists of a block of wood, usually the bole of a tree, which is hollowed on one side to form a basin, capable of containing 2 to 4 gantangs of padi and the opposite side is flattened to render the whole steady. Padi is placed in this "mortar" and pounded with a heavy cylindrical piece of timber, rounded at the ends until the husk is split from the grains. Using the "lesong" a Malay woman can pound 3 gantangs of padi in an hour, while a Tamil woman usually works more rapidly. Sometimes, instead of a small "mortar" a larger one of some 12 gantangs' capacity is used and 2 or 3 women pound the padi instead of one. Three coolies working in harmony in this way can hull and winnow 20 to 25 gantangs in an hour. The second type is the "lesong kaki" worked by the feet. (Malay "kaki"—foot). In principle this is a huge hammer, 6 to 8 feet long and of which the handle, a 4 inch beam, is pivoted near its end between fixed uprights, while the head or striking part is arranged to drop into a "mortar" of hard wood. The striking part is usually iron-bound and often studded at its extremity with nails or spikes to reduce the rate of wear. Having fed the mortar with padi the worker stands on the end of the beam behind the pivot and by pressing with his foot on the beam depresses the short end, causing the hammer striking end to rise 2 to 3 feet. By suddenly releasing the

foot-pressure the hammer end drops with considerable force and pounds the padi in the "mortar." The weight of the hammer beam requires a pressure on the short end of some 15—30 lbs. each time to raise the hammer so that this work is by no means light.

Usually the padi is hulled, then winnowed roughly and hulled a second time. The percentage of rice broken by this method depends on the age and condition of the padi.

The third type is the "lesong ayer" which is identical with the "lesong kaki" except that water replaces coolie labour. The water is led to a simple over-shot wheel, which is connected to a stout shaft. The shaft has a short strong wooden projection which, when the water pressure causes the wheel and shaft to revolve, exerts pressure on the short end of the "lesong" thus raising the hammer. The rate at which the "lesong ayer" can hull padi depends on the water-power, the greater the water-pressure the more rapid will be the hammering, but there is a limit to the rate of hammering as it is necessary for a coolie to stir up the padi in the "mortar" frequently preferably after each stroke of the hammer otherwise the rice is much broken. Sometimes the pounding is done by a heavy beam arranged so as to slide up and down vertically between fixed slots and in this arrangement the water power is, of course, used to raise the beam (hammer) directly in place of using a pivot and downward pressure. Each lot of padi is pounded twice as in the case of other forms of "lesong." Generally a "lesong ayer" is arranged so that the water-power works six or eight hammers at a time, a six-hammer one being capable of hulling 40 to 45 gantangs of padi per hour. The cost of a "lesong ayer" depends largely on the ready supply of water-power. The wheel, shaft and one "lesong" should cost about $70/-, while six "lesong" together with water-wheel and shaft have been erected for $160/-.

The second type of native hand-mill is the "kisaran." This mill consists of two circular grinding surfaces of which the lower one is fixed while the upper one, which has a central aperture, is free to revolve on a pivot and can be adjusted to regulate the space separating it from the lower one. Each grinding surface is about 22 inches in diameter and is composed of chips of "bakau" wood from 1½ to 3 inches wide and 1/8 to ¼ inch in thickness, sunk to a depth of 4 to 5 inches into unbaked, but hardened, pottery or white-ant heap clay. The whole mass is bound around by bamboo basket work to give additional strength. The "bakau" chips are spaced about ¼ inch apart and arranged in rows running from the centre to the circumference of both grinding surfaces; the chips in each row being set at an angle of about 30 degrees to the radii of the surfaces. Underneath the lower grinding block, thoroughly dried coconut fibre is packed tightly into the basket work which is securely held in a wooden frame, tightly pegged to the ground. The effect of fibre-packing is to allow a small amount of resiliency to the whole mill, thus reducing the tendency of the hardened clay to crack under the vibration of rotation. The basket-work binding the upper mill-stone is continued upwards to form the receiptacle for the padi which is to be milled. This basket is usually of some seven "gantang" capacity. The padi enters the

mill through a central aperture in the upper grinding block and through the same aperture the pivot from the lower grinding block projects. This pivot keeps the upper grinding surface in position. On the pivot rests a wooden beam which is embedded in the clay mass of the upper grind-stone and protrudes through the basket-work about one foot on each side. Through this beam there is a central aperture to admit the padi from the receptacle to the mill, and across this aperture there is a simple arrangement for raising or lowering the beam and thus regulating the distance between the grinding surface. The upper grinding-block is made to revolve at any desired rate by a simple and effective, though ancient, mechanical device. This consists of a strong wooden rod some 4 to 5 feet long bearing near one end a stout iron peg which fits loosely into a socket in the protruding end of the beam just mentioned. The other end of the rod is fastened rigidly to the centre of a wooden hand-piece which is suspended from a convenient height (about 6 feet) above the mill. The coolie grasps the hand-rod with both hands and by lunging forwards slightly can rotate the upper grinding block with the expenditure of very little energy. A uniform rate of rotation is essential. The rice together with the escaped padi and chaff, after passing between the grinding surfaces is retained in a trough formed around the mill by the continuation of the basket work encircling the lower grind-stone. In practice the padi is put through the mill once and then winnowed. Afterwards unhusked padi is separated from the rice by rotating the mixture smartly in a circular basket tray when the padi, being lighter then the rice, comes to the top. The padi so obtained is removed and again put through the mill. Another method of separating the padi from the rice, is to allow the mixture to run down a long sieve placed at an inclination of about thirty degrees. The mesh of the sieve permits the rice to drop through into a container while the padi trickles over the sieve and is collected at the bottom in another compartment. A strong coolie can hull and winnow twenty "gantangs" of padi in an hour and each mill can cope with 3,500 to 5,000 gantangs without renewing the grinding surfaces. A "kisaran" in Krian costs about $30/- and can be ordered through the Department of Agriculture.

VIII. INTRODUCED METHODS OF MILLING.

Hitherto Chinese milling initiative has coped with the surplus crops of padi which, as already mentioned, are only produced in Kedah, Province Wellesley and Krian, but since the erection of the Government Rice Mill at Bagan Serai four years ago, a fair proportion of the annual production is milled by the Government, and thus though the Chinese are still very strong they no longer hold the milling industry as an absolute monopoly. The output of the large power mills, of which there are ten, varies from 200 to 600 bags of rice per day of ten hours, and in a good padi season, there is sufficient padi to keep these mills running for 9 to 10 months. Almost the entire output of rice from these mills is in the form known locally as "parboiled", that is, it is partially boiled usually by steam heat under pressure, before being milled. This partial boiling causes rice grain to swell slightly thus rendering the hulling much more efficient and reducing the percentage of broken rice to a minimum.

The padi is heated for about 10 minutes in metal cylinders by steam under pressure (about 20 pounds per square inch) and then delivered into sacks which are conveyed to the drying floor. The parboiled padi must be thoroughly dried, as quickly as possible, before it can be milled. If the padi is not well dried the percentage of broken rice in milling is greatly increased, and further if the drying is too prolonged, the quality of the resulting product is impaired. The parboiled rice is very slightly polished before being sold to the dealers who retail it to estates for consumption. Indian immigrant labourers are the chief consumers of this type of rice preferring it to non-boiled, because it is more quickly cooked and because they are accustomed to its distinctive flavour. About 10% of the output from the mills is not so treated but milled raw and highly polished for sale to the Chinese population which favours well-polished rice because of its white appearance.

In addition to these large commercial mills there is a movement amongst employers of labour in favour of small power mills of sufficient capacity to mill padi for the supply of rice to their native employees. Several causes contribute towards the origin of this movement. In the first place the purchase of local padi, raw or parboiled, and the hulling of it by estates, would encourage local production and thus retain in this country a part, at least, of the large sum of money annually spent on the importation of rice from other countries. For this reason Government is endeavouring to stimulate the interest of employers of labour in estate milling. Secondly, the milling of padi by estates has been proved to be a financial success on estates adjacent to large padi producing areas. Estates so situated, besides reducing their expenditure on rice, and retaining a margin of the profits to cover capital expenses, are in a position to supply it to their coolies at less than the local market rates and thus estate milling tends to attract and stabilise labour.

Moreover, estate milled rice is of better flavour than purchased rice and far more wholesome than polished rice and therefore superior in quality to rice bought from local mills or imported. Furthermore, the use of estate milled rice would tend to reduce the incidence of "beri-beri" which is a food deficiency disease due to the absence of neuritis-preventing vitamines from the dietary and is a serious menace to certain sections of our labour forces, particularly the Chinese and the Javanese. The Far East Association of Tropical Medicine (1) is making a real effort to combat this disease which is mainly due to the overmilling of rice which causes a loss of the outer layers of the grain containing the vitamines. Beri-beri causes enormous loss of human life with corresponding invalidism and disability so that this Association has resolved that it is urgently desirable that the various Governments concerned should take action to discourage the use of highly polished rice containing less than 0.4% of phosphorous pentoxide which Fraser and Stanton (2) demonstrated to be the criterion of a satisfactory standard of milling.

Local medical authorities administer doses of an extract from rice polishings to counteract "beri-beri," but methods of prevention of the disease are more desirable than methods for curing it. The most obvious method of combating the disease, which is really due to ignorance on the part of the consumers of polished rice, is educative propaganda to demonstrate the relative food values of polished and unpolished rice.

Even employers of labour and the leisured classes of Orientals frequently show profound ignorance of the relative merits of unpolished and polished rice and since it would not be a wise policy to tax imports of polished rice the only solutions to the "beri-beri" problem are increased local production, including milling to the required standard as mentioned above and education, principally amongst the Chinese.

The selection of the right type of mill is a matter for each estate manager or employer of labour to decide, giving due consideration to the availability of power and the amount of rice required to supply his labour force. The same considerations apply to the size of store, the area of drying floor and, when parboiled rice is desired, the capacity of the soaking tank and of the boiling arrangements. The following types of mills are recommended in their order of merit as adjudged by the Department of Agriculture.

Power Mills.

A. The Engelburg Type.

This type of machine is made by several firms of which the best known are Messrs. Douglas & Grant and Messrs. McKinnon, both of Scotland.

The mill may be obtained through Messrs. McAlister & Co., who have branches in the larger towns of Malaya, or through Messrs. Guthrie & Co., or Messrs. R. Young & Co., at Penang. It is sold under various names, "The Planters Mill," "British Rice Huller,"

"The Engelburg Huller," etc., and costs locally at the present time about $650.00 which includes a stout stand for the mill. Messrs. Douglas & Grant's price is £42 sterling F.O.B. Glasgow. The machine requires 10—12 horse-power to drive it efficiently. It is compact, sound and simple in construction and the wearing parts are easily replaced.

The optimum speed is 500 revolutions per minute. At this speed the mill outturn of rice should reach about one hundred gantangs (700 lbs.) per hour, unless the padi used is of poor quality when it may he necessary to mill it twice, thus reducing output to about 60 or 70 gantangs per hour. The mill works quite well at slower speeds also but more breakage results and usually a few grains of padi escape unhulled.

The mill is equally effective with raw and with parboiled padi, the only difference being that slightly more breakage of the rice is experienced in milling raw padi. The rice produced is not rendered deleterious from the point of view of "beri-beri" disease since the milling is limited to hulling, no polishing of the grain being effected. The cost of erecting this mill should be small unless a separate mill room is required. The cost of fitting the machine to existing rubber machinery would vary according to the length of belting and the number of pulleys required and whether any additional shafts were necessary. A drying-floor is advisable since the padi must be thoroughly dry before being milled otherwise the percentage of broken rice is certain to be high. If parboiled rice is desired a drying-floor is a necessity.

The cost of a cement drying-floor should not exceed the rate of one dollar for every four square feet and the floor should slope slightly to promote rapid drying. The area of drying surface required would depend on the amount of padi to be milled daily. On the average thirty square feet is sufficient for drying thirty gantangs of padi, which is equivalent to twelve gantangs of rice, but at least double the day's requirement of padi should be dried daily until a fair stock of dry padi is obtained. In the case of parboiled rice the padi must be soaked in water for twenty-four hours, preferably with a few changes of water, and this is usually done in a cement tank of the required capacity, having an outlet pipe at the bottom for changing the water. The parboiling is most easily performed by using an open shallow iron pan ("kwali") capable of boiling about sixty gantangs of padi. This is fixed up over a brick and cement fireplace. A combination of 2 or 3 pans over one fireplace works well. On one estate the total cost of all the soaking and boiling arrangements was less than $120.00 including the shed under which they were placed. Whenever estate milling is contemplated a rat-proof store is essential since rats are large consumers of stored grain, and unless they are rigidly excluded, considerable losses of grain will be experienced. This is usually the most expensive item in setting up small power mills on estates, but its cost varies according to the nature of the building available, (if any), the cost of bricks, corrugated iron sheeting, close mesh wire-netting, etc. Another form of this machine includes a polishing drum. This form may also be used with safety from the point of view of beri-beri though it is better to remove half the polishing flanges from the inside of the polishing drum.

B. Under-Runner Hulling Mill.

This machine is manufactured by Messrs. Douglas & Grant (catalogue page B. 8) and retailed through Messrs. R. Young & Co., Penang or through Messrs. McAlister & Coy's branches. It is sold in four sizes of capacities varying from 300—900 "gantangs" of padi per hour that is, equal to an outturn of 120--400 gantangs of clean rice. The smallest size costs about $750.00 and the largest $1,650.00 at the present time. The power required for those mills varies from 2 to 4½ H.P. according to size. As this is purely a hulling machine, the hulls must, after milling, be separated from the rice either by wind or by some form of winnowing machine.

The hand-winnowing machine described in Section V is cheap, durable and effective and most local carpenters can make them at reasonable prices or they can be ordered through the Department of Agriculture. Power winnowers can also be used, but they are expensive and no more effective than hand machines.

HAND POWER MACHINES.

The only hand-power machine which can be recommended with confidence is the improved hand power rice huller, shipped by Messrs. Douglas & Grant (catalogue page R. 1) and obtainable locally through the Agents already mentioned in connection with power machines.

This mill is a combined huller and winnower. It is simple in design, very compact, easily adjusted, strongly constructed and practically 'foolproof.' The hopper is fitted with an efficient adjustable feeder which delivers the padi ..to the hulling discs in an even stream and a neat winnowing attachment blows away all the husks after hulling. The resulting rice is very wholesome and free from any injurious effects from the point of view of "beri-beri." This mill is eminently suitable for small estates not requiring a large amount of rice daily as its outturn is only 15 gantangs of rice per hour. The hand labour involved in working it is very light or the machine might be fixed to a motor cycle pulley as the power required is considerably less than 1 H.P. Care must be taken that padi is free from stones, nails or other hard particles which are liable to damage the grinding surfaces, before milling. The mill costs $400.00 and spare parts are readily available.

In case the supply of padi for milling in this machine, is very mixed, as it often is, the makers have designed a special hand-power compartment separator which divides the hulled from the unhulled rice after the first milling and the unhulled rice is then passed through the mill a second time. This Separator costs $500.00 and by using it the grinding discs of the huller can be set so that practically no rice is broken, unless the padi is very inferior or old stock. The separator can deal with 25 gantangs of milled rice per hour. A much cheaper and equally efficient separator can be made with a strip of strong wire netting of three-sixteenths inch mesh, and about six feet long, by encasing it with wood to make it rigid and placing it at an inclination of about 30 degrees to the horizontal. The mixture of rice and padi

is poured down this inclined riddle, the rice dropping through while the padi is collected at the bottom of the sieve. If the rice is very small grained it may be necessary to pass it down the sieve twice or even three times.

Should the padi be parboiled before milling, practically no grains escape unhulled and the amount of breakage is immaterial.

MILLING BY-PRODUCTS.

The chief by-products obtained in milling rice are broken rice, bran and hulls. Straw, though not sent to the mills, may also be classed as a by-product.

Broken-rice.—In milling padi a certain amount, usually around six per cent., of the grain is broken for various reasons and passes through the milling screens.

The chief causes of breakage include under-drying, over-drying, unripe grain, variation in size of grain, and faulty adjustment of the mill. Under-dried or unripe padi becomes chalky and crumbles up in milling; overdried padi becomes too brittle and splinters readily. Inferior grain shows a wide range of variation in size and thus renders adjustment of the mill a difficult matter. Grading the padi before milling corrects this factor to a certain extent, but sufficient grading is rarely done. The correct adjustment of the mill can only be achieved by experience and depends on regular supplies of the same types of padi. This by-product is found to contain a large percentage of the embryo of the kernals and hence it produces a very nutritious and palatable food, but on account of its high fat content it turns rancid rapidly. It provides an excellent feed for cattle, pigs and poultry, and is sometimes used for human consumption in years of shortage. Table X shows the food values of the various by-products of rice compared with wheat and oats.

TABLE X.

——	Water. %	Ash. %	Protein. %	Fat. %	Carbohydrate. %	Fibre. %
Padi ...	10.24	9.45	7.44	2.24	65.50	9.29
Rice Straw ...	11.80	12.99	8.25	0.62	36.80	35.01
Rice Hulls ...	8.97	18.29	3.50	0.49	26.96	41 89
Rice Bran ...	10.67	11.35	10.38	10.44	54.26	14.75
Broken Rice ...	11.79	...	8.19	2.56	77.46	...
Unpolished Rice ...	...	..	9.88	...	69.67	...
Polished Rice ...	...	...	6.56	...	77.55	...
Maize ...	12.20	1.50	10.40	5.00	69.40	1.50
Wheat ...	10 20	1.90	12.40	2.10	71.20	2.20
Oats ...	9.20	3.50	12.40	4.40	59.60	10.90
Barley ...	9.80	2.70	11.50	2.10	69.80	4.60

Rice Bran :—This by-product is usually sold in two grades, (occasionally three), according to the amount of finely broken rice it contains. The bran contains most of the protein of the rice grain, some ground kernel and hull. The amount of bran produced depends largely on the adjustment of the mill and the type of milling. In using the native "lesong" the amount of bran produced is considerable. Bran forms a rich food for the stock-yard, but does not keep long on account of its high fat content.

It is an excellent food for horses, chickens, hogs and cattle, but given as a sole diet is liable to cause stomach trouble. It should be mixed with sweet potatoes, maize, linseed cake, etc, according to the stock.

An extract from bran, particularly the bran derived from the polishing machine, is used medicinally in the treatment of beri-beri in many hospitals in the Tropics.

Rice Hulls.—Hulls are fibrous and unpalatable and of no value as a food because they contain little digestible matter. They are chiefly used as fuel to drive the mills, since they are inexpensive and burn with little smoke. The ash derived from the hulls is occasionally strewn on the padi fields as a manure if labour is cheap but the practice has little to recommend it since the ash contains less than one per cent of potash and of phosphoric acid. The most economical method of applying the ashes is to strew them in the irrigation water and thus let them be carried to the fields. Hulls make a useful nitrogenous manure for rice, fruit trees or gardens, and are frequently used for this purpose in the Malay holdings.

Rice Straw.—The straw when properly cured provides an excellent fodder, rich in protein and carbohydrates. It is occasionally woven into mats and sacks and can be manufactured into paper, as in Japan. In Malaya. the straw has no economic value since the climate provides an abundant supply of fresh grasses for our limited stock of cattle and horses and it does not pay to convey it to the towns for sale as fodder. It is possible that finely chopped straw or compressed baled straw would pay, if a large market was accessible, but the local demand for straw is very small.

The question of utilizing padi straw has been referred to in Section IV where it was pointed out that the straw is usually left on the fields because it had no monetary value. The inadvisability of removing the straw because of its manurial value, unless other manures are applied, was also mentioned.

1. Resolutions of the 4th Congress of the Far Eastern Association of Tropical Medicine.

2. Etiology of Beri-beri—Fraser and Stanton—Studies of the Institute of Medical Research F.M.S., 1911.

IX. PESTS AND DISEASES.

Padi, like most cultivated plants, is subject to the attacks of pests. In many districts of Malaya constant watchfulness has to be exercised to prevent serious crop losses owing to the depredations of rats and birds; whilst various insects are annually responsible for much damage.

Rats (i) are often particularly destructive to seedlings and grain, for example, it has been estimated that in the Krian district of Perak alone, this pest destroys each year at least six per cent of the crop or approximately one million gantangs of padi, which quantity would be sufficient to feed 10,000 Malays for one year. This estimate, however does not take into account the damage done to padi in store which must be considerable. Rats are usually more numerous in fields which adjoin kampongs or uncultivated land for in these places they can take refuge and breed during the period between harvest and sowing time.

The only really effective system of controlling this pest is to adopt a combination of methods and put these in practice throughout each padi area. Although this may not be practicable at the present time yet a great deal of good may be done by combined local effort along the following lines.

Preventive Measures.—These include the removal and destruction of all accumulations of waste material such as straw, husk and chaff: the rat-proofing of buildings and bins; the filling in of barrows with sand, glass, tar or similar material; the fumigation from to time of unprotected store-houses, burrows and bins—the best fumigant is carbon bisulphide,—the protection and where necessary, the care of natural enemies for example, herons, owls, snakes, hawks, cats, dogs and the mongoose.

Methods of Destruction.—These comprise trapping, hunting and the use of poisons. There are many forms of traps employed such as guillotine, cage, deadfall and barrel, but as rats are so cunning these are usually only effective for a limited time in any one place although their usefulness may be greatly increased by frequent change of position and by varying the nature of the bait. By systematically hunting rats in houses, stores, trees and fields whereever practicable much good may be done. Varnish and bird lime make effective traps also.

Poisons.—Stomach poisons in tempting baits are quite extensively used locally but great caution has to be exercised with the majority of these to prevent their being eaten by useful domestic animals and birds. The poisons commonly used are white arsenic, sodium arsenite, barium carbonate and phosphorus paste. These are

mixed with suitable baits and placed in the haunts of the rats. The poisoned baits, made up as small cakes about an inch in diameter may be coated thinly with paraffin wax to preserve them from rain or mildew and dropped about the fields at about ten feet intervals. Prepared in this manner, baits are very effective.

Full details of the preparation of the baits are given in the Agricultural Bulletin Vol. IX., No. 4, 1921, pp 272-274. It may be mentioned that in Krian an attractive bait is provided by the common green grass-hopper. The insect is caught and killed and a pinch of arsenic or other poison is inserted into a split made along the back of the insect. The bait is then placed in a suitable position usually amongst a small heap of padi husks.

The rhizomes of a local plant the "Siak-siak" (*Dianella ensifolia*) are also used in some districts. In this case mature rhizomes are pounded up and boiled with ten times their volume of rice and the bait placed about the fields in small heaps. An examination of the "Siak-siak" rhizomes' showed that they contained large quantities of fine needle shaped crystals of calcium oxalate which possibly act as a powerful mechanical irritant when ingested.

Birds.—Numerous small birds attack the padi when in ear and several ingenious and many laborious methods are adopted for scaring them away from ripening crops. The most common method is to place empty kerosine oil tins on tall sticks placed upright about the fields. All these sticks are then connected by a long rattan or "mengkuang" string. A child pulls one end of this string at frequent intervals thus causing the tins to jangle and the noise scares the birds away.

The poisons used to destroy rats can be used against birds also, the strengths of the several poisons being reduced to one third of those recommended for rats. Much loss of grain can be prevented in each area if planters so arrange the planting of different varieties that they will all mature simultaneously. In varietal tests it has been found that early ripening plots are almost completely consumed by birds, so that all varieties are now planted so that they may mature at approximately the same time.

INSECTS:

At the outset it may be mentioned that any unfavourable conditions which tend to weaken or check the growth of the padi plant such as poor soil, too much water, drought, stagnant water and weeds, also increase the liability of the plants to be damaged or killed by insect pests.

The chief pests which suck the juices of the plant and grain are the bugs "Kutu bruang" (*Podops coarctata*) and "Pianggang" (*Leptocorisa varicornis* and other species). The "kutu bruang" is black in colour, about ½ inch in length and slightly less in breadth. The nymphs and adults suck the sap from the base of the plants and when present in large numbers so

weaken it that it is unable to produce any grain. No satisfactory method for controlling the pest has been found for places where water for flooding the fields is not available. It has been frequently shown that if attacked padi fields are flooded the nymphs and adults rise to the surface of the water when they can be collected and destroyed. It has also been observed that this pest is capable of living in the stubble and growth of the previous crop for it has been found in lands newly prepared for planting the following crop. Eggs, nymphs and adults often appear in the nursery beds and if attention is paid to planting out only clean seedings the chances of damage by this pest would be reduced. An egg parasite has also been found which checks this pest.

The " Pianggang " commonly causes extensive losses of padi. It is recognised by its greenish brown colour, elongated body and its habit of sucking the juices of the developing grain. Sucked grains are readily recognised by the characteristic circular punctures one-thirty-second of an inch diameter made by this bug. The pest is capable of living on the inflorescences of various grasses and these may provide food for it after the padi is harvested and until the grain of the new crop has reached the milk stage. Preventive measures for controlling the insect such as keeping down grasses in the vicinity of the growing padi fields especially during the period when the land is not being cultivated should be adopted. During an attack the " Pianggang " can be reduced in number by systematically collecting it in hand-nets or by drawing elongated bags previously coated inside with some sticky material, such as crude oil emulsion, quickly across the fields. The eggs which are brownish in colour are conspicuous. They are laid in chain formation chiefly on the upper surface of the leaves and should be collected.

It is said that the pest will collect on baits consisting of putrid-meat placed in muslin bags and suspended in the fields, and that a large number can be caught in this way.

The small green Jassid bug known as "binak" (*Nephotettix bipunctatus*) which sucks the juices of the padi leaves is often quite a serious pest shortly after the padi is planted. A weak solution of kerosine emulsion, not exceeding 2%, sprayed on the plants is an effective remedy against this insect.

The stem-boring insects which are particularly troublesome and cause much damage are *Schoenobius bipunctifer* and *Diatraea auricilia*. These, besides killing the flowering shoots, tend to retard the ripening of the crop or to break its uniformity, thus causing additional loss at harvest. The former is usually predominent but the latter was more prominent in the earlier part of the 1921 season in the Krian district and had not been previously recorded as a pest of padi in Malaya. The preventive methods discussed for the control of the padi bugs already referred to, are applicable to these borers also. In small areas the application of "tuba" (the juice extracted from *Derris elliptica*) is most effective, but " tuba " can only be used where the padi is grown in water which is not mixed later with the drinking supply. A bird called locally Ruak-Ruak is said to keep this pest in check but the statement cannot be authenticated.

Among the leaf-eating insects which cause damage from time to time are larvae of the following: *Parnara mathias* which rolls the leaves and feeds inside them; *Nymphula depunctalis* and *Melanitis ismene* which are semi-aquatic and live in cases made of rolled pieces of leaves: *Spodoptera pecten* which may occur in enormous numbers when conditions suitable for its rapid increase prevail.

A minute eel-worm which was identified by the late Government Entomologist as *Tylenchus augustus* is a well-known parasite of padi in India. It occurs in the Krian district and causes some damage to roots and young shoots by sucking out their juices, but is not so far known as a serious pest. The infested plants have a sickly stunted appearance. Their leaves are pallid, and in the later stages of an attack the leaf-sheathes have brownish marks and the ears fail to mature.

The mole-cricket "Sorok" (*Grylotalpa borealis*) sometimes appears in wet padi nurseries where the soil has been allowed to remain above the water level for a few days or in dry nurseries. This pest which often destroys large numbers of seedlings can be guarded against, provided water is available, by lowering the nursery beds until they are just covered with water. In dry nurseries or where insufficient water is available, they may be hunted out of their burrows and killed or tempted with poison baits. A good bait consists of 30 parts broken rice or rice bran, 2 parts sugar, 1 part white arsenic and 10 parts juice of limes. The bran and arsenic are first mixed thoroughly. Then the sugar is dissolved in water and the lime juice added and this syrup is stirred into the bran to make a stiff paste. The paste should be placed about in small heaps 5 or 6 feet apart. About 4 katties of paste should be enough for an acre.

Grass-hoppers may also attack the nurseries but rarely do much damage. They may be given the bait used for cricket-moles or caught in large bag traps if very numerous.

The general control of padi pests presents many difficult problems. From an entomological standpoint, the practices of allowing stubble, selfsown padi etc., to grow after the crop is harvested is to be strongly deprecated because ideal conditions are maintained for the insects to feed and breed until the padi for the following crop is shown, though from the economic aspect the destruction of grasses and stubble is inadvisable except in extreme cases.

The eggs of *Podops*, *Schoenobius*, *Leptocorisa* and *Spodoptera* are frequently present in nursery plants and on account of the cultivator's ignorance are taken to the field on the seedlings whereas, they should be destroyed before the young plants are removed from the nurseries.

Pests of Stored Grain: There are several insect pests that attack padi and rice in store, and often cause serious losses. The most important of these are:—

Rice weevil (*Calandra oryzae*)
Angumois grain moth (*Sitotoga cerealella*)
Mediterranian flour moth (*Esphestria Kuhniella*)
Small Red beetle (*Tribolium castaneum*)
Saw-toothed grain beetle (*Silvanus surinamensis*)

Owing to its protecting husk, padi is less subject to the attacks of these pests than rice, hence the custom of the Malays to store the grain as padi and convert it into rice when required. The control of grain pests is most difficult in places where the storage rooms, bins or other receptacles cannot be made and kept air-tight. If air-tight they can be readily fumigated and all the insects killed. The most effective fumigant is Carbon bisulphide which is used at the rate of 2-3 lbs of liquid to every 1,000 cubic feet of space, but the gas given off is highly inflammable and poisonous, hence extreme care has to be exercised when employing it. A great deal may be done in the matter of preventing insect attacks by thorougly cleaning out stores and bins before storing grain in them. In the case of bins or barrels, steaming or scouring with boiling water to kill any pests that may be hiding in cracks or crannies is beneficial, provided that these receptacles are thoroughly sun-dried afterwards, When the padi is placed in stores or bins, it is important that these should be kept tightly closed, and only opened as required. It is needless to add that all grain should be perfectly dry before it is stored.

Much progress has been made recently by the Entomological Division of the Department of Agriculture with the study of the pests attacking the padi plant locally and the results will shortly be published.

Diseases.—Fungus diseases of padi are not unknown but do not, as a rule, cause serious losses of crop in Malaya. Occasionally "Smut" (*Ustilago* sp.) may attack the Grain of certain varieties and a species of "Phyllosticta" has been found on the leaves.

1. The Destruction of Rats—H. W. Jack—Agr. Bull. F. M. S., Vol IX., No. 4, 1921.

X. THE ECONOMICS OF RICE PRODUCTION.

The cultivation of rice has had its vicissitudes. Coincident with the enormous and rapid development of the commercial resources of the country, the cultivation of rice tended to decline until several factors acting together reminded the Malay that rubber and tin were not edible and that the policy of depending entirely on imported food-stuffs was not always wise. Nevertheless, apart from these factors and the ease of gaining other employment, the decline may also be attributed to the poor crops of rice obtained from much of the land by the customary methods of tillage. The cultivation of the rice fields is enforced in certain areas, but such compulsion is rarely necessary where the soil is capable of producing anything like a reasonably profitable crop and in poor land where crops are precarious such compulsion is unjustifiable.

The Malay prefers life in a 'kampong,' as a rule, but he harbours no delusions about the labour of following the plough, or swinging the "changkol" and will not indulge in these practices unless he is spurred on by the prospect of a fair return for his labours; this should cause no surprise, for what farmer worthy the name would think of cultivating his land, regardless of the returns at harvest.

The appeal to the health and charm of rural life is vain amongst folk who must earn their daily bread and not until the Malay can be assured of a certain profit from padi cultivation and one which will compare favourably with that to be derived from other occupations, is it reasonable to expect him to show more enthusiasm for the cultivation of his rice fields. Padi production is doubtless largely affected by the economic law of diminishing utility, for while the Malay thoroughly realises the advisability of producing sufficient to supply his own wants, he sees no point in labouring to produce additional padi for which he can hope to gain little profit at normal prices. Next to his own food supply, his chief incentive to work is his desire to obtain some material advantage, usually measured in money, and his reward for additional work in the padi fields is so small, that it is insufficiently attractive to arouse his energies.

The total efficiency of production depends on several conditions. The chief of these is the aid which nature supplies in the fertility of the soil which, as has already been mentioned, is very variable and though land rarely ceases to respond to increased cultivation, it often affords only a diminishing rate of return. Other conditions include the supply, average ability and industry of labour, the demand for labour, the rent of land, the incidence of pests, water-supply, the accessibility of markets, the wealth of the cultivators, industrial organisation, etc. The urgent demand for labour in the rubber industry and the comparative ease of estate work coupled with high wages and the cheapness of imported rice seriously threatened to ruin

the rice industry until restricted shipping curtailed imported food supplies during the war. The recent slump in the rubber industry once more compelled the Malay to attend to his rice fields, but without these natural and unforeseen forces, the Malay is unlikely to apply arduous toil to the production of meagre and unprofitable crops of padi; and this is only natural. Thus, unless increase of population and the consequent struggle for existance exercises the necessary compulsion, all but the most fertile rice lands are liable to be abandoned, as long as the rubber industry continues to prosper. The average costs of production vary considerably and except in Krian are extremely difficult to estimate in terms of cash since communal labour is adopted to a large extent. In the Krian district the cost of production can be readily gauged since contract work is common because many of the Malays are comparatively wealthy and Malays in easy circumstances rarely do the hard work which rice cultivation involves. The cost of cultivation and harvest per acre on first class land works out as follows;—

(1)	Preparation of nursery and sowing same ...	$ .80
(2)	Seed 2 gantangs @ 12 cents per gantang ...	.24
(3)	Cutting grass and weeds	4.50
(4)	Removing weeds etc.	4.50
(5)	First and second transplantations ...	1.50
(6)	Final transplantation	6.00
(7)	Weeding	3.00
(8)	Rent and water rate (80 cts.) & ($3.00) ...	3.80
(9)	Harvest—15% of crop (say 500 gantangs padi) @ 11½ cts. per gantang	8.63
		32.97
	Gross returns 500 gantangs @ 11½ cts. per gantang	$57.50
		32.97
	Profit per acre	$24.53

Thus in first class land in Krian, even on contract rates, padi production is profitable and doubtless the profits are much greater in the case of communal labour or where each family does its own cultivation. The price (about $225.00 per acre) which this type of land commands in Krian confirms its profitable return moreover those who do not rent this type of land from Goverament are always willing to hire it privately at $16.00 per acre per season.

On second class land in the same district, the profit approximates $7.00 per acre when contract labour is employed while third class land can only be cultivated profitably by the owners of land in good years and can never show profits if contract labour is employed.

On harder soils where ploughing becomes necessary the costs of production are considerably higher and profits are proportionally smaller, because buffaloes are scarce and demand high rates of hire and not only is the land ploughed, but it is also harrowed to destroy the weeds and rolled to reduce the soil to an even texture. Kuala Kangsar district affords a good example of this type of land. In this district cultivation and harvesting operations work out as follows:—

(1)	Preparation of nursery and sowing ...	$ 1.50
(2)	Cost of seed 3—4 gantangs	.40
(3)	Cutting weeds (frequently not done) ...	4.50
(4)	Ploughing 7 days @ $1.20 per day ...	8.40
(5)	Harrowing 3 days @ $1.20 per day ...	3.60
(6)	Rolling 3 days @ $1.20 per day ...	3.60
(7)	Transplanting (including preparation of seedlings)	6.00
(8)	Weeding	3.00
(9)	Repairing water courses and "batas" ...	1.20
(10)	Rent	1.00
(11)	Harvesting, threshing, winnowing ...	14.40
	Total ...	$47.60
	Gross returns, 400 gantangs padi at 12 cents per gantangs	48.00
	Profit per acre per season	$ .40
	Profit, if the cutting of weeds is ommitted ...	$ 4.90

Under this type of cultivation the yields vary betweed 200 and 500 gantangs of padi and 400 has been taken as the average from good land to show a profitable margin, though in reality the average is lower. On poor lands, therefore, no cash profit can be shown.

The above figures represent the costs of padi cultivation when undertaken by an outsider employing free labour and also represent its position compared with other industries e.g. rubber. They were in, fact, the actual contract or labour rates fixed in experimental areas, in both districts.

The ordinary cultivator who owns his own land, buffalo and implements and works the land himself (aided by his family) can doubtless show better returns, for the labour of cultivation only requires the work of three persons per acre for 25 to 35 days per season.

The cost of working an acre of padi land varies in different districts but in all probability thirty-two dollars represents the lowest cash equivalent for efficient cultivation. True, the costs are reduced in some districts (usually poor ones) below this figure by omitting or neglecting some part of the cultivation at the expense of the crop, but this is false economy and should be discouraged. The point of note is, the cost of cultivation in bad and good land is approximately the same so that the possible profits depend entirely on the nature of

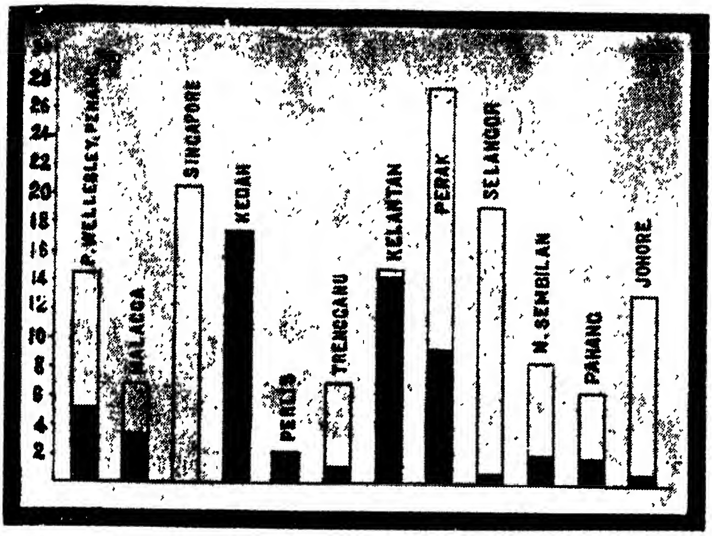


Diagram A. The ratio between Consumption and Production (black) in each State.

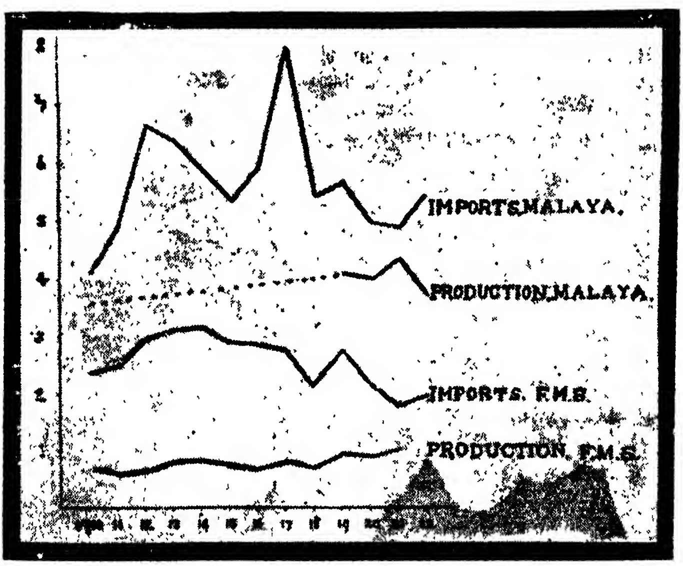


Diagram B. The Variation in Imports and Production in millions of pikuls of rice.

the fields (including water-supply). Under poor rice growing conditions, in terms of cash, cultivation results in heavy loss, but from the point of view of the grower it is nevertheless a profitable transaction because his holding, averaging between 2 and 3 acres, supplies the staple article of diet for himself and his family for the year at the cost of about eighty days labour in all. For this reason, thousands of acres of poor padi land are cultivated annually in Malaya. For example the "tenggala" system of cultivation in Pahang if regarded as an investment can only be classed as a dismal failure whereas from the Malay view point, it is the source of his food supply and as such is profitable in his eyes.

Padi cultivaiion is essentially a Malay industry. The large numbers of imported Indian and Chinese coolies are employed mainly on estates and tin mines respectively, they have little chance of acquiring or renting padi land and few of them have had any experience of the rice crop, consequently in estimating the total possible production of Malaya, due consideration must be given to the statistics of Malay population, for, for all practical purposes this element only of our population is engaged in padi production. The 1921 Census shows that there are 892,106 Malays of working age (15—55 years) in the Peninsula out of a total Malay population ol 1,594,699. Of these 453,246 are classed as "rice planters" and to this number may be added those classed as "estate owners" and "planters unspecified," nubering 57,483 since it is quite conceivable that many of them may own padi land or plant padi, making a total of 510,729 or 57% of the total Malay population of working age. The remaining 311,377 (or 43%) of working age are engaged mainly in fishing (37,805) and as agricultural coolies on estates (95,950) and in other necessary pursuits. Therefore 510,729 are responsible for the planting of the rice fields of Malaya which during 1921-22 season covered 669,262 acres, that is, each adult Malay cultivated 1.31 acre which falls very little short of the maximum area which one adult could cultivate efficiently.

Again assuming every male over 15 years of age to be head of a family there are 336,680 families in Malaya. Assuming that of these 20% are engaged in industries other than rice production (in reality there are more) the remaining 80% or 268,344 families cultivate annually 669,262 acres per family, or approximately 80% of the area which one family can cultivate properly.

The average rate of production of wet padi in Malaya is 203 gantangs per acre and 100 gantangs of padi are equivalent to 42 gantangs of rice therefore 2.48 acres produce 210 gantangs of rice. This amount of rice is sufficient to feed four Malays reckoning on an average consumption for all ages of 50 gantangs per annum ; or 2 adults and three children, reckoning 30 gantangs per child under 15, 60 gantangs per man of working age and 50 gantangs for women and old men.

Regarding the problem of production from another aspect 135,991,280 gantangs of padi (57,116,337 gantangs of rice) which represent the average annual production of Malaya for the last three

years are sufficient to feed 1,142,326 Malays of all ages or 72% of the Malay population. Over 30% of the total population consists of children under 15 years of age so that if due allowance is made for these the annual prodnction is sufficient to feed approximately 1,325,000 or over 80% of the Malay population. The above considerations show that the Malays almost provide for their own rice supply and could not possibly produce much more padi because suitable land is difficult to find, and one family cannot efficiently cultivate more than 3 acres. The total population of the Malay Peninsula is 3,322,603. Asming us an average consumption of rice of 50 gantangs per head per annum for all ages and calculating on the present rate of production of padi per acre (208 gantangs) 1,954,472 acres of land, (or roughly three times the present area) would be required to be cultivated annually to supply the total needs of the Peninsula. At the present time it would be imposible to cultivate this area because skilled labour, which is essential, is not available in sufficient number. Also it would not be possible to find suitable land to aggregate to this area, so that the most rapid means of increasing local production must lie along the lines of improvement of the conditions affecting existing areas and of increasing average crops. In the past it has been regarded uneconomic to aim at the production of our total food requirements. It was assumed that tin and rubber were the essential industries of the country and that they should be developed at the cost of food production on the grounds that imports of rice were cheap and plentiful. The late war has disclosed the erroneous nature of this policy and efforts are now being made to extend the present area under padi gradually and to stimulate rice production generally. There is no hope of the country being able to produce its total requirements of rice under present agricultural conditions and on account of scarcity of skilled labour, though there may be sufficient land available in the unopened tracts of Kedah, Kelantan, Trengganu, Selangor and other parts of the Peninsula.

That the tin and rubber industries supply the finances which defray the cost of administration of our Government is undoubted, but without rice a large proportion of the labour masses engaged in these industries could not be kept in the country, so that rice is, in reality, the first essential requirement of Malaya.

It is possible that a crisis such as that which occured in 1917-1918 may never happen again, but is it not advisable to keep the phantom of the rice shortage of that period dimly in view, particularly where the alienation of land is concerned, so that land which is eminently suitable for padi cultivation may be kept for that purpose and protected from harmful silting or the contamination of water supplies.?

The seriousness of the position of this country in regard to rice supplies is indicated in diagram A which portrays the ratio between consumption and production in the various States and Settlements in Malaya. Each column represents the proportionate consumption or requirements in the State or Settlement indicated and the blackened part of each column represents the average annual production. Thus Kedah, Perlis and Kelantan (with a very small import) are the only

States in which the supply satisfies the demand. Malacca and Pahang produce almost half their consumption. Perak, Penang and Province Wellesley and Negri Sembilan produce approximately one-third of their requirements and Trengganu only about one-sixth. In Selangor, Johore and Singapore the production is negligible.

The average annual import of rice into Malaya from 1910 to 1922 is 5,462,000 pickuls, if the abnormal import of 1917 is omitted. The average annual production of Malaya calculated on the four years 1919 to 1922 is 3,578,700 pikuls of rice (135,991,280 gantangs of padi therefore the ratio of production to imports is 5 : 8 in round numbers.

As regards the Federated Malay States alone the figures are somewhat worse. The average imports since 1910 being 2,592,000 as against an average production of 810,000 pikuls so that the ratio of production to imports is roughly 1 : 3. The average cost of importing rice to feed our labour masses since 1910 is over $31,000,000 per annum.

Diagram B shows the annual variation in production and imports of rice into the Federated Malay States and the imports into Malaya since 1910. Unfortunately, the figures of production of Malaya are not available prior to 1919, since no crop returns were prepared in Kedah or Kelantan before that date. These two states produce nearly 60% of our locally grown supply, but since they have been little affected by the rubber industry and their populations are chiefly devoted to rice growing, it might be assumed, with a fair degree of safety, that their production was maintained at an average, allowing for a small increase in proportion to the increase of population. The curves of imports are prepared from the figures in table XI which were kindly supplied by the Commissioner of Trades and Customs and the curves of production are prepared from the padi returns annually collected from District Officers.

From the curves it can be seen that the imports correspond very closely to the variations in the state of the rubber industry. Thus, the 1910 rubber boom caused imports to increase steadily in the Federated Malay States and rapidly in Malaya as a whole, until the outbreak of war in 1914 which depressed the imports in 1915. The high price of rubber (fifty pence) in January 1916, again had a stimulating effect on the imports but this was soon set back in the Federated Malay States by the enhanced price which rice demanded culminating in 1920 in costing the country more than one hundred million dollars. The only point in the import curves which does not correspond with the condition of the rubber industry is the import of over eight million pikuls of rice into Malaya in 1917.

As regards production in the Federated Malay States the curve follows the progress of the industry fairly uniformly. Thus, the curve traces the fall in the price of rubber from 1910 to 1911 and thereafter the comparative steadiness of the price until native holdings of rubber became profitable in 1913. This was followed by a marked tendency to neglect rice for the more paying cultivation of rubber.

until shortage of ships forced up the price of rice in 1917. This increase in production would undoubtedly have been maintained in 1918 had not the influenza epidemic of that year caused a decided shortage of skilled labour with consequent smaller acreages under rice.

This increased cost of imported rice followed by the slump in the rubber industry combined to cause a continued increase in production right up to 1922. In Malaya as a whole the production shows a heavy decrease from 1921 due, partly, to the reduced price of imported rice which immediately affected the rice industry adversely in those States which were mainly devoted to rice cultivation, but chiefly, to the unfortunate weather conditions experienced in that season in Kedah, a state which furnishes one third of our annual production and in which that padi season was "bad beyond all precedent."

The gradual increase of Malay population, (nearly 2% per annum) has naturally, a slight stimulating effect on the production of rice, but the big increases in imports are almost entirely due to the employment of large numbers of immigrant coolies on rubber estates.

In passing, it may be mentioned that the bulk of our rice imports comes from Burma, which is the cheapest and steadiest market available. Imports from Siam and Indo-China are variable in amount since their exports depend entirely on the season's production. Moreover, they do not export cheap rice.

The contention that Malaya is not a rice growing country, is hardly applicable since our average production of 1,020 lbs. per acre per annum (wet and dry) is ~~higher~~ than the average in Burma and India and we have big areas which can produce as much as 2,600 lbs. per annum. Approximately, half of our padi is produced in small areas in narrow valleys along the banks of streams and rivers where pests notably pigs, rats and birds abound and damage every crop considerably. The large flat coastal areas which are much more suitable to rice production and much less liable to animal pests have been planted up with permanent crops which could be better grown on the undulating foothills further inland. The rubber boom of 1910 is responsible for this state of affairs but there are still available several large alluvial areas suitable for rice cultivation, which if irrigated and made occupiable would attract padi planters Naturally the costs of irrigating and rendering large areas fit for occupation would be heavy, but if due consideration is given to the fact that each family settled on such land would produce its own rice supply and in addition, enough to feed two or possibly three other families, then the matter assumes an important aspect. Besides thus tending to reduce our large annual imports of rice, which are a heavy drain on the resources of the country, such settlers would become available for other types of industry and thus serve the country as a double asset. Malay settlers might not be immediately available in the vicinity of large areas suitable for padi cultivation but provided that the land is good, the water supply assured and that the area is made readily accessible, suitable settlers could be induced to leave districts where

no good padi land exists or where it has all been planted to permanent crops. Moreover, the Malay population is annually increasing by over 20,000 souls and this increase could be used to develop newly opened rice lands provided that they were easy of access.

TABLE XI.

Imports and Exports of Rice (including padi calculated as rice) in Thousands of Pikuls.

——	Federated Malay States.			Straits & Unfederated States.			Net Imports F.M.S. and S.S.	Values of Column 7.
	Imports.	Exports.	Balance.	Imports.	Exports.	Balance.		
1910 ..	2,636	289	2,347	10,401	8,641	1,760	4,107	$14,779,000
1911 ..	2,788	272	2,516	10,441	7,997	2,444	4,960	$18,882,000
1912 ..	3,156	158	2,998	11,724	8,044	3,680	6,678	$36,302,000
1913 ..	3,431	293	3,138	12,786	9,539	3,247	6,385	$29,558,000
1914 ..	3,426	230	3,196	13 327	9,514	3,813	7,009	$28,789,000
1915 .	3.145	239	2,906	13,572	11,178	2,394	5,300	$22,306,000
1916 ..	2,997	142	2,855	15,446	12,315	3,131	5,986	$25,507,000
1917 ..	2,872	105	2,767	17,946	12,667	5,279	8,046?	$38,110,000
1918 ..	2,301	128	2,173	13,958	10,680	3,278	5,451	$33,157,000
1919 ..	2,823	34	2,789	7,654	4,739	2,915	5,704	$63,642,000
1920 .	2,394	199	2,195	5,538	2,742	2,796	4.991	$101,517,000
1921 ..	1,947	125	1,822	7.596	5,923	1,673	3,495	$13,911,000
1922 ..	2,097	107	1.990	9,548	6,063	3,485	5,475	$25,500,000
Average net imports ..	..	..	2,592	..	..	2,885	5,162	$34,188,000

(*To be continued.*)

THE

Malayan Agricultural Journal.

Vol. X. July, Aug. & Sept. 1923. Nos. 7, 8 & 9.

RICE IN MALAYA.

By

H. W. Jack.

(Concluded.)

XI.—VARIETIES.

OVER 1,700 so-called varieties of padi have been collected in Malaya, judging by the vernacular names, but of these many differ only in name in different districts and in reality there are probably not more than 300—400 distinct varieties in the Peninsula.

An effort has already been made to classify Malayan rices and a considerable accumulation of data has been obtained, but the urgency of more important work has necessitated the postponement of the final classification to a future date, and experimental work has been concentrated on the leading varieties. Varieties of padi differ in shape, size, colour and hairiness of grain, in the length of the maturation period, in yield of grain per acre, in length of straw, in tillering power, in numerous vegetative characters, in culinary and milling qualities, in chemical composition and in other ways. Different local varieties of hard rice that is, those which have a vitreous fracture, can be grouped broadly into the following distinct classes according to the shape, and size of grain.

(*a*) Seraup type, which has a distinct shoulder on the anterior extremity of the grain.

(*b*) Radin type, which is very uniform in outline and of medium length.

(*c*) Siam type, which is always very long and frequently slightly curved.

(*d*) Rangoon type, which is markedly broad and thick in proportion to its medium length.

All the rices so far found in Malaya can be placed in one of these categories, but by far the most important classes are the Seraup and Radin types which probably include 80% of the total production.

(*a*) The Seraup type, which is most popular amongst the millers because of its weight and good milling qualities, is chiefly confined to the large flat coastal areas of Krian and Province Wellesley and to heavier clay soils around Kuala Kangsar and probably represents 25% of the annual crop.

It is commonly called a heavy ("berat") padi because of its high yielding ability and its long maturation period which averages 285 days, though strains can be bred to shorten or lengthen this period by 14 days. Strains of this variety in very fertile soil are capable of producing crops up to 850 gantangs of padi per acre in exceptionally good seasons and in first class land. Under average conditions the crop is rarely less than 500 gantangs per acre.

There are two chief sub-divisions of this type:

(1) "Seraup Besar" which has a long grain with a white tip.

(2) "Seraup Kechil" which is shorter and has a coloured tip.

"Seraup Besar" is known also as 'mayang,' 'mayang sakapol,' 'sakapol' etc.

(*b*) The Radin type is most popular because of its excellent culinary qualities and for this reason is common in all the smaller padi areas where the crop is grown for home consumption only, though it is also found in the larger areas in Kelantan, Kedah, Krian and other places. This padi is not very popular with millers because of its lightness compared with 'seraup' and because of the smaller size of grain. These factors have adverse effects on its milling qualities by raising the ratio of husk to kernel as compared with 'seraup.' Probably 50% of the annual crop is derived from this type which includes many sub-varieties of which the best known are "radin puteh," "radin merah," "radin kuning," "nachin," "riong," "lebat," "santap," "serendah." The variation in the maturation period of this class is very wide, its limits including 4 and 9 month varieties.

(*c*) The Siam type is rarely grown on a large scale but is quite common in small areas where it is chiefly cultivated on account of its large kernel and is used for food at special social functions. This type includes several varieties which are all probably descended from types introduced from Siam. They mature in 4 to 7 months.

(*d*) The Rangoon type: The bulk of the rice imported into Malaya annually comes from Rangoon and is characterised by its short, fat and thick shape. Doubtless locally grown rice of which the grain conforms to this type is descended from seed imported from Rangoon, but very little padi of this type is seen in cultivation in this country. Varieties of this type mature in from 4 to 6 months.

In contrast to the hard rices there are numerous varieties of glutinous rice ("pulut") characterised by their fracture which is never purely vitreous and by the fact that they boil to form a more or less gelatinous mass. They are of little economic import since

their consumption is limited to special ceremonial occasions and because as a diet they contain too much fat and are lacking in proteins. The most popular varieties are 'hitam,' 'galah,' 'kuching lekat,' 'labah,' 'chiakbong,' 'minyak,' 'kunpit' etc.

The method of studying varieties has been by means of pure lines. From the entire collection of varieties some 300, representing the most popular types in all the chief producing districts were grown as pure lines for five seasons.

For each season's sowing the seeds from a single plant only of each type were sown, the resulting seedlings being planted in rows of one hundred plants. Thus each type was represented by one hundred plants in each season, and records of botanical and agricultural characters were registered and checked each year.

Particularly promising types, from the point of view of yield, were multiplied and tested against selected 'seraup' and 'radin' strains, these tests still being in progess as all tests must cover at least three seasons so as to give an insight into average yielding ability under the seasonal variations which occur from year to year. Thus these tests raise the study of varieties from the level of a mere piece of academic research to a work of practical utility and at the same time furnish a check to observations made while the particular variety was grown in line culture.

Seasonal variations, with particular reference to rainfall, complicate the testing of varieties or strains considerably, for it is frequently found that a variety or strain under even slightly different climatic conditions on the same soil may give very diverse yields in two successive seasons.

Hence in testing work, it is necessary to strike averages over a period of several seasons in order to make sure that a given variety or strain is really more valuable than others and of course, the averages become the more reliable in proportion to the number of seasonal tests from which they are derived.

The following table shows the agricultural characters under Krian conditions, of some of the leading varieties in cultivation. Their botanical characters will be dealt with in a future paper on cassification. They are classed as "wet" padi in contrast to "dry" or "ladang" padi but several can be grown under either form of cultivation, for example, Sungkai, Bidor, several Radins, Gansar, Riong etc.

Variety.		Field No.	Type.	Maturation period (days.)	Average height (ins.)	Average tillering.	Average yield of gram per plant (4 years)
Seraup kechil	...	52	Seraup	230	60	23	93
" "	...	36	"	235	18	21	94
" ,	...	186	"	246	68	21	81
" besar	...	590	"	240	63	20	76
" "	...	15	"	233	65	21	85
Radin kuning	...	7	Radin	207	18	20	86

Variety.	Field No.	Type.	Maturation period (day.)	Average height (ins.)	Average tillering.	Average yield of grain per plant (4 year.)
Radin merah ...	4	,,	191	45	19	76
,, puteh ..	13	,,	200	48	20	80
Pahit ...	896	Seraup	212	60	20	86
Pahit ...	903	,,	200	54	19	83
Machang ...	273	,,	235	51	18	
Labah ...	668	Pulut	218	48	22	58
Hitam ...	697	,,	231	42	25	67
Nachin puteh ...	642	Radin	217	48	21	59
Bujang melengong.	862	,,				
Burong ...	779	,,	200	48	12	59
Bunga machang ...	653	Seraup	167	45	15	44
Rangoon ...	649	Rangoon	140	30	12	40
Siam ...	667	Siam	180	48	20	72
Siam ...	820	,,	181	48	21	73
	876	Ceylon	150	36	25	35
Gading kuning ...	630	Radin	185	48	22	91
Chantek ...	683	Seraup	180	60	23	95
Pontianak ..	634	Radin	182	48	21	90
Bidor ...	635	,,	196	51	20	80
Selatan besar ...	636	,,	220	51	16	75
Jintan tinggi ...	637	,,	181	48	15	53
Manik ...	638	,,	185	54	14	52
Seri layar ...	638	,,	240	60	20	38
Rantai mas ...	640	,,	163	48	21	56
Nachin ...	641	,,	175	45	20	70
Negri ...	643	,,	190	54	20	61
Bunga belimbing...	645	Seraup	190	60	17	60
Mayang bawang ...	646	,,	225	63	21	50
Kedah ...	647	Radin	195	54	16	57
Bunga machang ...	652	Seraup	190	60	22	72
Serbok mas ...	659	Radin	172	51	15	63
Radin deli ...	666	,,	219	48	16	67
Nias ...	689	,,	184	42	12	48
Sungkai ...	690	,,	186	33	8	35
Radin patani ...	691	,,	182	39	16	51
Seri bumi ...	692	,,	216	48	15	62
Jarom perak ...	710	,,	190	54	18	65
Anak ikan ...	726	,,	182	48	11	54
Antah beras ...	727	,,	185	54	16	69
Rendah ...	875	,,	151	30	28	60
Lebat ...	749	,,	220	48	23	55
Tukal ...	789	,,	184	48	18	58
Gansar ...	792	,,	221	45	13	80
Bemban ...	821	Seraup	241	60	23	58
Riong ...	849	Radin	179	54	16	54
Punggong hitam ..	808	Seraup	243	60	15	47

XII.—CORRELATIONS.

A. Relationship between yield per plant and tillering power.

Although it has already been pointed out in section 4 that tillering varies enormously according to the fertility of the soil, yet under similar conditions, the variation fluctuates about the mean for each strain and each strain has its own inherent tillering ability. Thus the tillering powers of pure strains, 9, 52, 99, 36, 6, 217, were found to be 14, 18, 16, 20, 21, 22 respectively in season 1921-22. These figures are the averages of counts from 40 plants of each strain, all the strains being grown side by side in the same field under apparently similar conditions, care having been taken to avoid soil within 20 feet of the 'batas' (divisions between fields). In establishing a correlation between tillering power and yield of grain per plant, the object was to determine whether the tillering power of a plant could be used as an index of its yielding ability. For the conduct of the experiment twelve pure strains of the variety 'seraup kechil' were grown in rows of forty plants each, side by side, each plant occupying one-and-a-half square feet, this being found to be the optimum spacing in Krian. At harvest the mature ears of each plant were cut and bound in a bunch. When thoroughly dry the number of ears (fruiting tillers) in each bunch was recorded. Then each bunch of ears was hand threshed, and winnowed and the clean padi was weighed separately. Thus records of the number of tillers per plant and of the weight of grain per plant from 480 plants were compiled. From these records a mathematical calculation shown in table XII was made to determine any existing correlation between these characters. This calculation revealed a correlation coefficient of .72 $\pm$ .0186 which indicates that there is a definite relation between these characters, so that strains having a high tillering power must be selected if increase in yield of grain is to be attained.

In actual experimental tests pure strain No. 9, for example, with an average tillering power of 14 had only an average yield per plant of 53 grammes, this strain having an average of 21 tillers in season 1921-22.

Naturally since seasonal variation has a direct effect on the tillering power of a variety or strain, comparisons between the tillering power of different strains can only be made during the same season and on the same block of land and preferably with as large a number of plants as possible. Thus in contrast to season 1921-22, the tillerings of the pure strains mentioned above were found to be respectively 17, 23, 19, 22, 24, 21 in season 1922-23.

TABLE XII. Correlation between Tillering and Weight of Grain per Plant.

Mean tillering = 19 : Mean weight = 78 Classes-tillering M = 19

Classes-Weight M = 78.

	5	8	11	14	17	20	23	26	29	32	35	fy	dy	fdy	fd²y	E dx dy
157										2		2	79	158	12482	2054
142							1	5	8	2		16	64	1024	65536	9344
127						7	6	7	14	5	2	41	49	2069	98441	15533
112					4	11	31	17	6	1		70	34	2380	80920	10846
97				2	23	37	25	6	2			95	19	1805	34295	2717
82			1	10	32	39	19	1	1			103	4	412	1648	40
67			10	19	21	19	5	4				78	-11	-858	9438	1650
52		2	6	21	9	3	3	1				45	-26	-1170	30420	4446
37	3	1	9	8	1							22	-42	-902	36982	6847
22	1	4										5	-56	-280	15680	3248
7	2	1										3	-71	-216	15336	2769
fx	6	8	26	60	90	116	90	41	31	10	2	480		4362	401178	59494
dx	-14	-11	-8	-5	-2	1	4	7	10	13	16					
fdx	-84	-88	-208	-300	-180	116	360	287	310	130	32					
fd²x	1176	968	1664	1500	360	116	1440	2009	3100	1690	512					

fdy: $wy = \frac{4362}{480} = 9.08$; $w^2y = 32.45$

fd²y: $\frac{401178}{480} = 835.78$; $w^2y = 82.45$; 753.33; $wy = \sqrt{753.33} = 27.45$

E dx dy: $\frac{59494}{480} = 123.737$; less wx. wy $= 7.082$; 116.655

375 $wx = \frac{375}{480} = .7812$; $w_2x = .6099$

$\frac{14535}{480} = 30.2812$; less $w^2x = .6099$; 29.6713; Dx 5.454

$$R = \frac{116.655}{5.454 \times 27.45} = \frac{116.655}{149.60} = .779 \qquad E_r = \pm \frac{.67\,(1-R^2)}{\sqrt{N}} = \pm \frac{.67 \times .606841}{21.9} = .0186$$

$\therefore R = .78 \pm .0186.$
R = Coefficient of Correlation.
E_r = Probable error of R.

(B.) Spacing in Transplantation.

In Malaya wet padi is almost entirely sown in a nursery and later transplanted into the fields, most frequently with one transplantation only, but in very rich soils the seedlings are often transplanted twice, occasionally thrice and rarely four times. Transplantation of seedlings is undoubtedly beneficial, the advantages following this practice being a considerable saving of seed, a marked increase in yield and an improved quality. The chief disadvantages of transplantation are the necessity for a large supply of labour at one time, the necessity for opportune rains in the absence of irrigation, to enable the fields to be thoroughly prepared, and a decided lengthening of the maturation period of the crop. The physiological factors involved in transplantation are somewhat obscure but the conclusion at present, based on a number of experiments, is that transplantation acts in a similar way to root-pruning, the injury to the root system stimulating the growth of the sub-aerial portion and resulting in increased tillering. The root system of transplanted rice is developed from the lower nodes of the stem, the first or seedling root system dying completely in most cases. In very rich soil like that in Krian complete amputation of the original root system is the common practice. It was found that, in the best soils of Krian where three transplantations are the rule, that seedlings which had only been transplanted once gave a large vegetative growth but practically no grain. It was also found that if the original root system was not heavily pruned at the final transplantation, that the resulting plants were slow growing and eventually gave little grain. The origin of the custom of triple transplantation of seedlings in Krian cannot be traced, but the practice must have been evolved from many years of experience. Old men who have been planting rice in Krian for over forty years state that this practice has been in vogue as far back as they can remember. The practice affords a striking example for it shows that, where padi planting is concerned, most of the present day methods of cultivation attain a high degree of perfection from the point of view of the physiology of the rice plant and that the methods of the Malay planter are usually adopted with reason resulting from long experience.

The spacing of seedlings in final transplantation into the fields depends entirely on the nature of the soil, the thoroughness of cultivation and the average depth of water. In the richest parts of Krian or near the "batas" the optimum planting distance was found to be twenty by eighteen inches, this spacing producing a yield of over 600 gantangs (3,300 lbs.) of padi per acre. In the middle of the fields where there was no "batas" effect and in good soils the best distance was found to be seventeen by fifteen inches (3000 lbs. of padi per acre). In medium and soft soils, under average rainfall conditions, fifteen inches each way proved the best distance (2,500 lbs. of padi per acre). In hard medium soils one foot each way appeared to be the optimum distance under average conditions, but with more thorough cultivation the distance can be increased by 2 or 3 inches. In the better soils, it was found that close planting was always followed by severe damage by rats and that the optimum planting distances had to be reduced by nearly one fourth if the water was too deep (over eighteen inches) at the time of final transplantation.

These planting distances were determined by planting the same variety of padi ("seraup") on several one fortieth acre plots on the various types of soils mentioned. On each type of soil the padi was planted in duplicate plots at distances varying from ten inches square to twenty inches square and the yields of cleaned padi were recorded by volume and by weight. In most areas the Malays appear to have struck good average planting distances, though in Krian where the manurial effect of the "batas" are the most pronounced, they have hardly made sufficient allowance for it. Thus, under native planting conditions, it has been found that on the average an acre of padi cut so that none of it is more than twenty feet distant from a "batas" produces 1.7 times as much grain as an acre of padi cut se that none of it lies within twenty feet of a 'batas.' The high productive power of soil situated close to the 'batas,' is of course, entirely due to the richness of the soil in humus, which is derived from the decay of the vegetation used in constructing it. In areas where the soils are very hard the "batas" are made of stiff clay only and as such, produce little or no manurial effect on the padi growing near them.

C. The relation between the number of plants per hill and (a) tillering (b) yield.

It has already been indicated in section 4 that the tillering of padi plants, though an inherent character, is very considerably affected by environment. The chief environmental factors which affect the tillering power are the depth of wàter, the soil, the spacing of the padi plants and the number of plants per hill in final transplantation. With regard to the last mentioned factor an experiment was conducted in which several small plots were planted with the same variety of padi. ('Radin puteh') the hills being spaced at the optimum distance for the area (17 x 15 inches) but in each plot the number of seedlings planted per hill was varied to ascertain the effects on tillering and yield. The reslts are tabulated below:—

No. of Plants per hill	No. of tillers per hill (average of 100 hills)	Average Yield of padi per 100 hills	Average Yield per hill in grammes	Yield per acre in pounds
1	13.3	5,460	54.6	2,964
2	14.5	5,370	53.7	2,917
3	15.5	5,480	55.0	2,976
4	17.1	5,270	52.7	2,862
5	17.0	5,110	51.1	2,775

The experiment was conducted on first class land and the table shows that the tillering increases in proportion to the number of plants per hill up to four, though above this number the tendency is to decrease. At any rate as far as tillering is concerned, it makes little difference whether 1 or 4 plants are set to each hill.

The yield per hill and per acre show a definite tendency to decline when more than three plants are planted per hill. The Malays usually plant three to six seedlings per hill in transplantation

except in the best soils where the seedings become very robust before final planting and are easily handled so that the number used per hill is reduced to 2 or 3. In final planting the work must be done quickly hence the number of seedlings used really depends on the ease with which they can be handled, so that the number must vary according to soil conditions, for if the seedings are weak and thin, the planter cannot afford to waste time in singling out one seedlings at a time, when three or four can be picked up more quickly.

D. The Relation between the weight of padi grain and its value as seed.

Every grain on thirteen medium sized ears of padi, representing three well known varieties, was weighed and placed in a paper bag after its position on its parent ear was noted by a numbered diagram. In this way, over 2,000 grains were treated and sown in nursery boxes, each seedling being labelled and later transplanted to the padi fields. All seedlings were protected from rats by wire netting. At harvest the produce from each plant was weighed separately and the following table shows the results from two typical ears :—

GROUP Weight in Grms	Total no. of grains in group	Total no. of grains in group to germinate	Per cent. of total no. of grains	Average Weight of Crop per plant in grms.	
				Grain	Straw
Ear 4 : variety 'Padi pahit.'					
.0000	1	0	0	0	...
.0125	13	0	0	0	...
.0150	11	3	27	47	...
.0175	2	1	50	47	...
.0200	6	4	67	52	...
.0225	12	7	58	48	...
.0250	29	21	72	49	...
.0275	75	48	64	46	...
.0300	38	26	68	44	...
.0325	10	6	6	42	...
Ear 12 : variety 'Seraup'					
.020	7	7	85	75.7	347
.021	5	3	60	67.8	340
.022	8	5	62	56.0	317
.023	28	16	70	97.5	369
.024	35	25	72	78.2	388
.025	36	24	67	80.0	329
.026	20	13	65	96.8	395
.027	12	7	58	85.7	102
.028	3	2	67	80.3	415

The table shows that the very light grains are useless and should be avoided in selecting seed, and they usually are, since the Malays generally immerse their seed in water so that light and empty grains float to the surface and are discarded. Once the light seeds are eliminated the remaining seeds show a like percentage of germination and apparently possess similar producing powers (allowing for experimental errors) as evidenced in column 5 of the table. The position which each grain occupied on its parent ear does not appear to have any effect on its value as seed. Theorizing from scientific principles this is the result that was expected for the essence of modern plant breeding demands that every seed of a pure strain should have the same germinal capacity regardless of size, provided that it is grown in a healthy and similar environment and has properly matured (mutations excepted).

XIII.—MANURES AND GREEN-MANURING.

Manures :—

Though little practised in Malaya, the application of manures as a means of increasing production is fairly widely known. The main reasons why manures are not universally employed are probably bound up with the lethargic disposition of the people, who prefer to eke out a bare subsistence with the expenditure of the minimum of energy rather than to apply themselves to the task of growing surplus rice for sale.

The rice cultivator is not ambitious, his wants are simple and easily supplied and he is accustomed to work but three months in the year, hence, since he finds that the old methods employed by his fathers are capable of gratifying his personal requirements, he is too conservative to launch out into new agricultural methods. Nevertheless, manuring is almost an established practice in several districts of Malaya though the method of applying it and amount applied are usually far from satisfactory, and certainly do not approach economic perfection. The manures which are known to be used by the cultivators include bone-meal, blood-meal, guano and green-manure in the from of grass and weeds. The first two mentioned are chiefly used in Malacca and parts of Negri Sembilan and are applied in various ways. Sometimes the nurseries only are manured, sometimes the nursery is manured and later the seedlings from the nursery are dipped into a thick manure paste before transplanting them into the fields. Frequently the nursery is unmanured, but the seedlings are plastered with manure paste and barely kept moist for 2 to 3 days or until their roots show through the paste, and then they are planted out in the fields. Commonly neither nursery nor seedlings are manured but the manure is run in with the water supply or broadcasted on the soil when fully prepared for planting. The amount of manure applied by this latter method is usually about 60 lbs. per acre and this amount is roughly approximated in manuring the seedlings also. Guano is in common use in Perlis, Kedah and parts of Perak but the guano used differs considerably in chemical and physical composition and also in price according to quality. The amount of phosphate in different samples of guano has been found to vary from 6.3% to 32%, but deficiency of lime in most samlpes renders the phosphoric acid "unavailable" to a large extent (1)

In Perlis and Kedah the Malays recognise three classes of guano classified according to colour as black, chocolate or light brown. Black guano is sold at $1.50 per bag, chocolate commands $0.75 per bag, and the poorer light brown stuff fetches $0.40 per bag, the bag containing roughly 25 " gantangs," or about 200 lbs.

The guano is broadcasted at the rate of three or four bags per acre every second year and the results are said to be good.

The Kedah phosphates contain more phosphoric acid than the Perlis samples as a rule, but aluminium and iron are so much in

excess of lime that the mass effect of the latter in rendering the phosphoric acid available is practically negligible. As nitrogen fertilizers these phosphates have a small value and in this respect the Kedah samples show superiority."

In studying the question of manures for rice soils, the problem must be approached from two aspects. In the first place it is necessary to know definitely the nature and amount of the constituents taken by the padi plant from the soil, secondly, the chemical and physical compositions of the soil must be determined by analysis.

The proportion of straw to grain and husk on good padi soils is roughly 5 : 4. The following table shows the average amounts in pounds of the chief constituents taken from the soil by a crop of 500 gantangs of padi per acre, as calculated from chemical analysis (2).

	Dry weight.	Nitrogen.	Potash.	Phosphate.
Straw ...	3,500	24.5	60	2.5
Padi ...	2,800	42.0	10	9.5

The straw amounting to about 3,500 lbs. per acre and equivalent to 24.5 lbs. of nitrogen 60 lbs. of potash and a small amount of phosphate is left on the land. The padi (grain and husk) removed annually from the land amounts to some 2,800 lbs. and contains 42 lbs. of nitrogen, 10 lbs. of potash and 9.5 lbs. of phosphate, so that theoretically these constituents should be returned to the land in the amounts indicated if the fertility is to be maintained. The growth of grasses which accumulates on the fields during the fallow period returns part, at least, of the required amount of nitrogen, as well as a certain amount of potash and a little phosphate, but the land is bound to deteriorate if the supply of any one of these necessary constituents becomes insufficient for the crop, although it has been shown is Section III, that local rice soils contain a supply of these constituents sufficient for at least twenty crops.

Once the land becomes deficient in any one of these three constituents the law of the minimum comes into force and the crop suffers in consequence. Heavy applications of nitrogenous matter have little or no beneficial effect on the grain crop, if the soil does not supply the minimum potash and phosphate requirements, nor is there any wisdom in applying heavy dressings of potash or phosphate if the soil is lacking in nitrogenous content. Thus, although our soils contain a stock of nutrient material sufficient for a long period, our fields have already been tilled for many years and the time is bound to come when the existing supply will be reduced below the minimum required for the rice crop. Even land which still produces good crops can benefit greatly by the application of manures, and the application of various manures to their land by Malays is an admission of the truth of this fact. The harder soils which must be ploughed before planting are most likely to show the beneficial effects of manures.

Manurial experiments were carried out at Lubok Merbau in the district of Kuala Kangsar, but owing to the curtailment of expenditure they were not continued long enough to render their results definitely reliable.

The experiments were designed to test effects of the simpler manures on the padi crop from the point of view of yield of grain.

Each manure was applied to two duplicate plots situated in different parts of the experimental area. At harvest each plot was divided into three or four sub-plots of one-fortieth of an acre each and the yield of each sub-plot was carefully measured.

The yields per acre were then calculated from the average of all the sub-plots under each manure. All the plots were similarly cultivated and were planted up with the same strain of padi ('Radin puteh' from the Krian Experiment Station). Moreover, all planting was done within one week so that climatic conditions should be similar in each case. The only factors which adversely affected the experiment were the unequal severity of rat attacks and the fact that a few plots were better situated as regards water supply than the others.

The land was first cleared of weeds and then ploughed. The application of manures immediately followed the ploughing and two to three weeks later the land was harrowed, irrigated and finally rolled.

The following table shows the average results of the two seasons over which the experiment was continued.

Manure.	Rate per acre.	No. of plots.	Average yield per plot.	Yield per acre.	Increase %
	cwts.		gantangs.	gantangs.	
Control ...	...	8	11	440	...
Cowdung ...	10	6	12¾	510	15.9
Basic slag ...	5	6	12½	500	13.6
Wood ashes ...	5	8	12	480	9.1
Nitrolim ...	2	6	12½	500	13.6
Super-phosphate	5	6	12¾	510	15.9
Sodium nitrate ..	3	6	12½	500	13.6
Perlis guano ...	5	5	9¼	370	—16.
Potassium sulphate ...	3	5	14¾	590	34.
Ammonium sulphate ...	3	5	8½	340	—22.7
Fish guano ...	5	6	10¼	410	— 6.8
Lime ...	10	5	13	520	18.2
Oil cake ...	3	4	12¼	490	11.3

Cowdung, wood-ashes and Perlis guano were included in the experiment in view of their cheapness and the possibility of creating large supplies. Bonemeal, which is already fairly well known as a manure was omitted because, though ordered, it did not arrive with the other manures, and could not then be obtained in time.

Cowdung is well known as a good manure for padi throughout Malaya, but as cattle are scarce, so little is available that the cultivators hardly deem it worth while to put it on their land. The application of half a ton per acre produced an increase of 16% over the control plots. This amount of cowdung is, however, insufficient and it is considered that about four tons per acre would be required to give the best results.

Wood-ash proved fairly useful though disappointing in its result showing only an increase of 9% compared with the controls.

Perlis guano was a failure but this was due, partly at least, to the fact that one plot was very poorly supplied with water compared with the average and suffered badly accordingly, thus seriously reducing the average of all the sub-plots. One plot under lime and one plot under potassium sulphate were particularly favourably disposed with regard to water supply, and each carried a heavier fallow crop of grass than the average, but still the manures had an evident beneficial effect. One plot under ammonium sulphate and the adjacent one under fish-guano were covered with silt to a few inches as the result of a burst in the "tali ayer." This silt had a noticeable effect on the padi in the reduction of tillering and consequently showed diminished yields. Super-phosphate was the best of the remaining manures but the question of costs and the intrinsic values of the manures cannot be dealt with since prices have varied so enormously in the last five years. As mentioned above these experiments were intended to investigate the effects of simple manures and further experiments in this direction are being planned to start this year. In addition, however, combinations of various manures will now be tested. The merits of applying artificial manures to various green manure crops will also be studied since the writer is of opinion that there are great possibilities in this direction, provided that water supply can be fairly well controlled.

These experiments are useful in showing the fallacy of relying on trials which have only been continued over a short period. for under such conditions the effects of manures are masked by environmental factors, some of which are uncontrollable. The longer the trials of this nature are continued the more reliable do the results become, but in no case can definite conclusions be drawn until experiments have been continued for at least five years.

(1) Composition of Kedah and Perlis Phosphates—V. R. Greenstreet. Malayan Agricultural Journal. Vol. XI. No. 3, 1923.

(2 Some Rice Soils—M. Barrowcliff. Agricultural Bulletin F.M.S. Vol. I, No. 12, 1913.

Green Manuring.

Green manure is not conveyed to the padi fields, nor are green manure crops planted, but the thick growth of rank grasses and weeds, which springs up between the padi seasons is cut down and permitted to rot on the land for some weeks or is ploughed into the wet soil in the reparation of the land for planting. This practice is almost universal in Malaya. Moreover, in harvesting the crop in this country, it is customary to leave the straw on the land, only the ears being removed from the fields. In ploughing or trampling in this straw in the preparation of the land for the following season little of the organic matter produced in the crop is lost whereas if the hulls and straw are burned on the fields sixty-three per cent of the organic matter (about 21 lbs. of nitrogen) they contain is lost in the burning Therefore the practice of burning the straw after harvesting the crop. should be vigorously discourged. The only exception to this rule is the case of a field which has been very seriously damaged by insect or fungoid pests. It would not be economic to burn the straw on fields which had only been slightly infested with pests, indeed the writer has never known any insect or fungus attack to be sufficiently destructive to rice in Malaya to warrant the burning of the straw and grasses.

The incorporation into the soil of the rice straw and grasses grown on the land is beneficial to the following crop, but the amount of this green manure is rarely sufficient to give the best returns and the utility of importing additional vegetable matter to the land is usually reflected in the returns from the crop. The best method of applying green manure to rice land depends on whether the land is readily drainable and whether it contains an abundant supply of potash and phosphates.

In Malaya the heaviest producing lands are often found to be of a soft velvety consistency all the year round. Land of this nature usually produces a luxurious growth of rank grasses in the fallow season which when cut and permitted to rot on the fields forms an excellent green manure. Large areas of this type of land are found in Kedah, Province Wellesly and Krian and smaller patches occur here and there in the valleys in Rembau, Kuala Kangsar and Malacca.

The yields of rice obtained from these soils would indicate that a soft puddle was the most effective medium for producing fertility suitable to the needs of the rice plant. Such soils require no addition of nitrogenous manure though potash and phosphoric acid might be instrumental in producing heavier crops.

On most other types of land the fallow vegetation is more scanty and means for increasing the nitrogenous content of the soil are advisable. Green dressings of grass, leaves or other succulent vegetation can be placed on to the land prior to or during the preparation of the soil for the rice crop or if such material is not available a green manure crop can be grown on the land itself and later incorporated with it.

As the water supply is not controlled in most padi areas and as our rainy seasons are not very well defined, the sowing of green manure crops is attended with varying results. It may happen that the land is still flooded at the time when green manure seeds should be sown, or shortly after the seed has germinated the young plants may be killed by inundation due to heavy rains, or again the seedlings may be parched by excessive drought and thus produce little vegetation. The best time to sow green manure seeds is about three or four weeks before the padi crop is harvested when under normal conditions the water is being drained off the land The land is then of a thick muddy consistency and supplies ideal conditions for the rapid germination of the seeds which should be broadcasted thickly and evenly. Thus the seedlings get a good start before the land becomes hard and dry and they afford shade, after the padi is removed, which tends to keep the soil cool and to retain moisture near the surface to the further advantage of the plants.

As ordinarily understood the term "green manure" is limited to the use of leguminous plants because of the well known power which their roots possess of enriching the soil in this respect, though modern work seems to indicate that the power of roots to fix atmospheric nitrogen is not limited to plants of the natural order "*Leguminosae*." Used in a broad sense, however, the term includes any quick growing plant which can be grown to yield a supply of foliage suitable for incorporating with the soil to augment its nitrogen content. Grass, for example, when cut and turned into the soil forms an excellent green manure if applied in sufficient quantity especially in the presence of moistuie.

The following are the most promising leguminous green manures grown at the Krian Experiment Station:—

(1) *Sesbania aculeata*—A legume which grows rapidly and withstands varying conditions. This plant, broadcasted thickly in the padi fields a month before harvest yielded a mass of vegetation eight feet in height in five months and once it became well established it was found to endure flooding of the land for several weeks without any apparent detriment. It seeded well in the padi fields, but as the land in this district is usually fallowed for about 4½ months only it is advisable to keep a small plot growing elsewhere for seed purposes.

(2) *Cajanus indicus*--This plant will not tolerate standing water. It can be broadcasted thinly (5 lbs. to the acre) as with Sesbania or dibbled in hills spaced two feet apart each way. It forms a thick cover and sheds leaves abundantly thus adding a considerable amount of organic matter to the soil. The fallow season in the rice fields is not long enough to permit of seeding and the crop should be cut and incorporated with the soil after about three or four months growth before the stems become woody.

(3) *Tephrosia purpurea* like Cajanus will not stand submergence but grows fairly easily on wet soil. It should be thinly broadcasted

or can be dibbled into hills spaced two feet apart each way. It should be ploughed into the land when it is about two and a half feet high, that is after about three months growth.

(4) *Crotalaria juncea* grows quickly and produces a thick cover. It may be broadcasted fairly thickly and cut after three months growth before flowering and ploughed into the soil. It does not stand inundation for long.

(5) *Phaseolus mungo* (green) is difficult to establish on padi fields in its early stages but once established it thrives fairly well forming a useful green manure which should be ploughed after three months growth. In broadcasting about 10 lbs. of seed are required per acre.

(6) *Phaseolus mungo* var *radiatus* (black) is more difficult to establish than its green variety but produces more foliage and takes longer to flower and seed.

(7) *Canavalia eniformis* produces a heavy cover in three months but is difficult to establish in the heavy Krian soils.

(8) *Vigna catjang* grows rapidly forming a dense cover. The seed should be dibbled into hills about one foot apart in rows spaced about two feet apart. From the point of view of green manuring, the trailing variety is preferable and should be ploughed in just before flowering.

(9) *Centrosema Plumierii* is very difficult to establish on padi land unless conditions are exceptionally favourable and will not tolerate standing water. Surface cultivation assists the growth considerably and under good conditions a thick cover is formed.

The following table shows the average results of two seasons' trials with green matter added to the land in addition to that supplied by the natural growth during the fallow season.

	Manure.	Rate per acre.	No. of plots.	Yield of padi per acre.	Increase.
A	Control ...	...	4	410	...
B	Grass ...	10 cwt.	4	460	12%
C	Grass and Lime ...	10 cwt. & 5 cwt.	4	510	24%

In the above experiment, with regard to C. one of the plots was greatly favoured in its water supply, but still, it was evident that the lime increased the effect of the green material considerably.

Though results show which crops can be grown in the padi fields, experiments have not yet been carried far enough to show definite conclusions. There is however, no doubt as to the beneficial effect of green manures more especially in conjunction with artificial fertilizers.

It is found that if phosphates and potash are applied to green manure crops, the latter are more quickly established and form thicker covers, and field experiments are now being put in operation to test the value of this combination as measured in increased yields of grain.

XIV.—CATCH CROPS.

Intensive cultivation of the soil is not practised in Malaya except by Chinese market gardeners who laboriously work up all classes of soil rendering them very fertile and profitable. These gardens only cover a very small total area and are always situated near to the large towns where Chinese control the prices of vegetables and thus ensure to themselves sound returns.

There is room for considerable development of the padi fields of Malaya by the cultivation of catch crops during the fallow season, but it is doubtful if the cultivators, long accustomed to 3 months work in the year, will ever exert themselves to profit by such culture. Increase of population would appear to be the only force which is likely to arouse our cultivators from their inherent antipathy to strenuous effort and drive them to put their land to better use during the non-padi season. One crop of rice, a few coconut trees and unfailing sources of fish in rivers and rice fields together with easy earnings on rubber estates to cover the costs of luxuries such as tobacco and the average cultivator lives happily. Under these easy conditions of existence intensive cultivation of the soil is likely to remain confined to our Chinese market gardeners.

The following crops have given good results as catch crops at the Krian Experiment Station :—

(*a*) (*Ipomaea batatus*) Sweet Potato Malay ; Ubi Kledek.
In 1917, immediately after harvest half an acre of padi land was dug up, ridged and planted with this crop. This plot yielded 6,500 lbs of tubers or at the rate of 5.8 tons per acre. Dry weather prevailed throughout the entire growing period with the result that a high percentage of small undeveloped tubers was produced ; moreover the ridges were spaced six feet apart, whereas this distance might easily have been reduced to 4½ or 5 feet. No weeding was done.

	$—cts.
Chankolling and ridging ½ acre	13.65
Land rent (½ acre 5 months)	4.00
Cost of cuttings 1600 @ 10cts per 100 ...	1.60
Planting 4 coolies @ .40cts	1.60
Lifting and bagging ½ acre	6.00
Cartage to market 2 carts @ $1.50 each ...	3.00
Total cost of production ...	29.85
Sale of crop 48.45 pikuls (6,500 lbs) @ $1.00 per pikul	48.45
Profit per half acre ... = ...	18.60

Thus, though larger tubers would have fetched $1.50 or $1.75 per pikul, the crop, grown under very dry conditions, gave a handsome return, in fact a better return than would have been earned by planting padi.

(*b*) (*Arachis hypogaea*) Ground nuts Malay; Kachang goring.

Planted on ridges one feet high and 3 feet apart this crop yielded at the rate of 12 pikuls of nuts per acre. This yield might have been materially increased had the plants been spaced one and a half feet apart on both sides of the ridges instead of one foot apart on the top of the ridges only; moreover, weeding costs would then have been reduced.

	$ —cts.
Chankolling and ridging ½ acre	13.65
Land rent ½ acre 5 months	4.00
Cost of seed 20 katis @ 10cts per kati ...	2.00
Sowing 2 men @ .40cts each	--.80
Weeding 4 men „ „	1.60
Lifting and bagging the crop	6.00
Cartage to market 1 cart, 3 miles	1.50
Total cost of production ...	29.55
Sale of crop 6 pikuls @ $7/- per pikul ...	42.00
Profit per half acre	$12.45

(*c*) (*Ricinus communis*) Castor Oil Malay; Jarak.

This crop was grown successfully on the 'batas' of rice fields, when seed was dibbled in to a depth of 2-3 inches at intervals of four feet and lightly covered. No other cultivation was required. The seed was sown during the padi harvest in March and the crop was mature in August, yielding at the rate of 4 katis of seed per chain of batas. The seed was found to contain 30% of oil, employing the rough native methods of extraction, therefore the yield of oil per chain of 'batas' is approximately 1.5 katis (33 fluid ounces). Two coolies can hole and one cooly can easily expel the oil from 40 katis seed in a day.

	$—cts.
Cost of seeds, 1 gantang @ .40cts	—.40
Holing and sowing per 10 chains of batas 2 coolies @ .40cts each	—.80
Harvesting 1 coolie 5 hours @ 10ct per hour ...	—.50
Oil extraction 40 katis seeds 1 coolie @ .40cts ...	—.40
Total cost of production ...	$2.10cts.
Sale of oil from 10 chains of batas = 33 × 10 ozs = 2 gallons (approx) @ $2.40 per gallon (40cts per bottle)	4.80
Therefore profit per 10 chains batas	$2,70

Of course, castor is a crop which, if cultivated on a large scale, would soon swamp the market, but as the plant will only grow on the "batas" of the rice fields, the area could never assume very large proportions.

Moreover, the crop could only be grown on the 'batas' in the areas where the rice soils are soft since castor will not thrive in the heavy clay of which the 'batas' are composed in the areas where the rice soils are hard, and more than half the rice lands in Malaya belong to the latter category. In a district like Krian it might be profitable to establish small oil mills and a refinery if the Malays could be induced to sow this crop on a large scale and to prepare oil for export, or at least to supply the local demand, which is a large one. The labour involved in sowing and harvesting the crop is practically 'nil' and the clearing of weeds from the batas periodically would tend to reduce rat trouble, for rats breed prolifically in the batas during the non-padi season, so that castor would appear to be a good crop to grow wherever the batas are formed of soft decaying vegetation as in the Krian District.

Zea mays (Maize) Jagong.

Maize is perhaps the commonest crop grown by Malays on the batas in the North of the Peninsula. It is grown sometimes concurrently with padi sometimes as an intercrop, the more frequent practice being to sow it some 2 or 3 months before harvest. Seed is dibbled into holes spaced about one foot apart on the 'batas' and no cultivation is given to the crop which is rarely left to mature since it is mostly consumed in the green state as a vegetable. A portion of the crop is matured for the market or for seed purposes. The cost of cultivating and harvesting this crop is negligible and good yields are easily obtainable except in years of heavy rainfall which results in the submergence of the 'batas.'

Coleus parviflorus Ubi Kemeli.

This plant is grown on ridges in the padi fields for its tubers which form a good food and are readily saleable. The methods and cost of cultivation are the same as in the case of sweet potatoes. It is grown chiefly in Province Wellesley and commands prices similar to those obtained for sweet potatoes but is usually sold by the "gantang" as the tubers are fairly small (up to about three inches in diameter) and thus readily measured. Small parcels of this crop are sold at twenty cents per gantang. The yields obtainable from this crop depend entirely on the soil, the amount of cultivation and the weather conditions, all factors which affect the size of the tubers, very considerably.

Sagittaria sagittifolia Keladi Ayer.

This plant is grown in the rice field for its tubers in districts where Chinese predominate as it forms a good pig food. It is planted in much the same way as rice (transplanted) and under similar conditions of irrigation and is usually restricted to those rice fields which rarely or never dry in the non-padi season. It is most commonly seen in Province Wellesley but is found occasionally in Kedah, Krian and Malacca. The tubers are sometimes sold at two dollars per pikul (133 lbs) but are generally stored by the cultivator and fed to his pigs. The tubers are eaten by the Chinese to a small extent when other food is scarce.

Nicotiana Tabacum (Tobacco.)

Tobacco also grows readily on the rich soil of the "batas" in Krian and parts of Kedah, but like the castor-oil plant will not do well on the heavy clay "batas" found in most of the padi areas in Malaya. The tobacco plants spaced at intervals of three feet along the "batas" which are cleared of weeds, shoot up very quickly provided that light showery weather is experienced, and leaves become large and rank. The number of leaves is reduced to about fifteen by topping the plants when they are about two months old so that only large leaves are produced. The only cultivation necessary is occasional ring weeding around each plant and it is advisable to examine the plants for caterpillar pests periodically. Grown in this manner one chain of 'batas' produces at least half a pound of dry leaf with the expenditure of very little energy and yet few Malays take the trouble to ensure a cheap supply of tobacco for their own use or for sale to their neighbours or to local cigar factories.

Coix lacryma jobi (Job's Tears,) Menjelai.

This crop is occasionally grown on the 'batas' in Krian and Province Wellesley in the same way as maize. It is more commonly found in Pahang and Kelantan where it is grown sometimes, as an intercrop but is more often grown broadcasted with padi under "ladang" or "huma" cultivation.—Two types of "menjelai" are grown. A hard shelled type which is crushed and fed to poultry. etc. and a soft shelled form which is eaten. The grain is roasted to facilitate husking and boiled like rice or ground into flour for baking. The plant grows excellently on the 'batas' in Krian and matures rapidly giving a good crop. The only objection to this crop as a useful addition to Malayan cereals is that it ripens unevenly, though it might be possible to breed out a type which would overcome this defect.

Various other crops which are regularly grown in a very small way on the batas include several types of bears, (kachang) cucumber (timun) lady's fingers (terong) etc.

The success of catch crops, or intercrops, depends on several factors of which the following are the most important: they must mature in less than five months; they must grow easily and they must command a ready sale.

The crops above mentioned which can be grown in the rice fields either between the padi seasons, or concurrently with rice on the 'batas,' do not include all possible crops, but merely serve to show the scope of productiveness which is at present scarcely fringed.

The crops which can be grown in the non-padi season, would, moreover, tend to reduce the cost of padi production because their cultivation would leave the rice fields in a cleaner condition and thus reduce the cost of preparing the land for padi. In addition, the general effect of the extra tillage required in growing crops between padi seasons would be beneficial to the soil and hence tend to increase padi yields.

Custom, the inbred habits of the cultivators, and the ease of existence are all contributary causes leading to the general neglect of these sources of wealth and food production.

This state of affairs can only be altered by increase of population or by external forces tending to curtail our imports of rice. As our population is increasing slowly but surely, a time may come when the true value of subsidiary crops may be appreciated.

XV.—EXPERIMENTAL ERROR.

In comparing the yielding capacities of different pure strains or of different varieties of padi, it is necessary to adopt a standard range for errors in calculations which is generally known as the experimental error.

Not only in field work but in dealing with any scientific problem the first essential consideration is accuracy, whether in details of description of characters or measurements of volume, length, weight, etc., and the precision of accuracy attained is the most important factor in adjudging results. No measurements can be made with such a degree of accuracy that they can be regarded as absolutely correct, because there are always several independent sources of error to be considered.

Generally, errors can be divided into two groups. (1) Those which can be eliminated. These include errors in instruments such as a faulty measuring rod and a badly adjusted balance. Obviously these errors can be remedied by substituting good instruments for the poor ones or by compensation. To this group also belong personal errors, for instance the varying depths to which different coolies will tap a rubber tree, and mistakes in reading scales, computing calculations, and counting weights, which are common errors. (2) The second group of errors comprises those which are indeterminate in their nature and cannot be entirely eliminated, no matter how much care is taken in an experiment. The occurrence, even in small areas, of pockets of soil of varying physical and chemical composition may be taken as an example of this type of error.

It is this second group of errors with which the scientist is chiefly concerned for the errors included in the first group may be largely reduced by practice or by compensation.

Three methods are employed in determining the relative accuracy of measurements (a) The mean error, (b) the average deviation, (c) the probable error. Of these methods the mean error, (which is the square root of the arithmetical mean of the square of the errors) is seldom used in scientific work.

The average deviation (which is the sum of the deviations divided by the number of deviates) is the easiest to determine, but the "probable error" method is the most accurate and consequently the most popular.

The term "probable error" is rather misleading but its meaning may be made clear by defining it as a number placed after a result with a plus and minus sign between; and it indicates that it is an even wager that the true result lies between limits so indicated. The "probable error" is ascertained by submitting a number of results to the mathematical formula $P.E. = .67 \sqrt{\Sigma d^2 \div n\text{-}1}$ in which "d" is the

deviation from the mean and "n" is the number of results investigated. This formula is based on probabilities and was originally invented for and applied to astronomical calculations. In Season 1921-22 this formula was applied to 90 pure strains of padi of the variety 'Seraup Kechil,' in order to ascertain the experimental error in comparing pure strains under Krian Experimental Station conditions, in connection with pure line selection for increased yield of grain. Each pure strain was planted in triplicate in plots of one hundred plants each, each plot of the same strain being planted in a different part of the field. At harvest the weight of dry clean unhulled grain from each plot was carefully recorded and the weights are tabulated in table XIII. An examination of these results indicates that in most cases the yields of the triplicate plots are uniform. It is not possible to treat the yields of 270 plots of one hundred plants each directly by the method of least square for the evaluation of the "Probable Error" since the strains which produced the various lots of triplicate plots are inherently different. A comparison of strains 1, 20 and 36 discloses this fact. It is probable that environmental influence, such as the occurrence of rich pockets of soil, etc. contribute partially to the difference in yield of the different plots of each strain, but the large differences between the different strains are probably due to the different constitutions of the various strains of padi. It becomes necessary therefore to treat each set of results from the several strains in such a way as to bring them to a common basis of comparison so that finally they may be examined graphically and combined into one computation by the method of least squares. This can be done by assigning percentage values to each result, the percentage values being calculated on the mean yields of the plots of each individual strain. This has been done in table XIII. The primary object of this experiment was the detection of the measure of accuracy attainable in using small plots since in manipulating large numbers of pure strains the work becomes more amenable to supervision (within limits) the smaller the area under the crop. The application of the above mentioned formula to the figures contained in table XIII results in a calculated "Probable Error" of ± 10.7% which indicates that no significance can be attached to any result which does not show an increase or decrease of more than this amount when compared with any other result. The harvest, during which the figures used in the calculation of this probable error were compiled, was an exceptionally bad one. Heavy rains caused the padi to lodge in the fields which were flooded to a depth of 9 to 16 inches during the entire harvesting period.

Thus, much grain was lost before and in the process of cutting the crop, in transporting the grain from the fields, in threshing and later through germination of the grain which could not be dried quickly. In a normal harvest, plots of a size similar to those which were used in the experiment only gave a "probable error" of ± 3%.

The difference between this figure and ± 10.7% adequately portrays the havoc wrought by rains during the harvest.

In all pure line testing an experimental error of 10% which is considered a safe margin on which to base calculations, is assumed, except when a wet harvest occurs when it is raised to 12%.

The application of this experimental error is of extreme importance in the comparison of the yielding abilities of a large number of different pure strains in enabling selections to be made with the minimum of cost, from small plots.

It must be understood that the calculated "probable error" can only be applied to the land on which the experient was conducted or to land in the same neighbourhood where soil and cultural conditions are approximately the same. The same crop may, under varying conditions of soil, water supply, and cultivation, show a different "probable error" so that a result obtained, say in Krian cannot be safely applied to a crop grown in Malacca though it is unlikely to vary considerably from it.

For this reason, it is desirable that experimental stations in each typical area should standardise their soils by ascertaining the "probable error" of cultivation before making variety comparisons, testing different forms of cultivation of the relative merits of various manures.

The following experiment may be mentioned as an example to show how precautions were taken to reduce experimental error in weighing lots of padi in pure line selection work. When padi is harvested it contains a considerable quantity of moisture and it was necessary to determine what period, under average weather conditions, must elapse before the weighings should be taken until each sample had reached that condition. Five bags of padi of the same variety, each containing one gantang of grain, were weighed separately immediately after winnowing and at frequent intervals afterwards covering a period of thirty seven days. The weights of each lot in the following table :-

WEIGHTS IN GRAMMES OF FIVE BAGS OF PADI EACH CONTAINING ONE GANTANG

Harvested 7.4.21. Variety Seraup Kechil.

Dates of Weighing.		A.	B.	C.	D.	E.
8.4.21	...	2,737	2,770	2,770	2,732	2,719
11.4.21	...	2,606	2,661	2,662	2,628	2,662
12.4.21	...	2,591	2,644	2,647	2,614	2,592
13.4.21	...	2,542	2,586	2,596	2,556	2,539
14.4.21	...	2,527	2,567	2,582	2,542	2,522
15.4.21	...	2,512	2,547	2,560	2,522	2,498
16.4.21	...	2,502	2,542	2,552	2,512	2,492
18.4.21	...	2,502	2,542	2,542	2,507	2,491
19.4.21	...	2,499	2,537	2,537	2,506	2,482
20.4.21	...	2,494	2,532	2,532	2,502	2,477
21.4.21	...	2,479	2,514	2,517	2,472	2,472
22.4.21	...	2,469	2,502	2,489	2,457	2,445
23.4.21	...	2,459	2,492	2,482	2,445	2,442
25.4.21	...	2,459	2,481	2,479	2,444	2,434
26.4.21	...	2,456	2,480	2,470	2,441	2,429
2.5.21	...	2,472	2,497	2,497	2,462	2,452

Harvested 7.4.21. Variety Seraup Kechil

Date of Weight.		A.	B.	C.	D.	E.
3.5.21	...	2,467	2,492	2,472	2,462	2,452
4.5.21	...	2,468	2,502	2,502	2,467	2,447
5.5.21	...	2,477	2,507	2,507	2,472	2,457
6.5.21	...	2,477	2,510	2,510	2,472	2,461
14.5.21	...	2,497	2,522	2,522	2,497	2,472
15.5.21	...	2,497	2,522	2,522	2,492	2,472
30.5.21	...	2,480	2,490	2,520	2,480	2,450
29.8.21	...	2,479	2,495	2,517	2,478	2,452

The above figures indicate that the padi loses weight with fairly uniform rapidity up to the fourteenth day. Up to that period the padi showed an average loss in weight of 8.9%, the variation in weight after that period being dependent on weather conditions.

A final weight, taken 144 days after that first recorded proved this statement.

TABLE XIII.

Pure line No.	Plot No.	Wt. of Grain in Grammes	Mean.	% Mean.	D.	D^2.	ΣD^2.
1	1	6,000	5,670	106	6	36	
	2	6,000		103	6	36	216
	3	5,000		88	12	144	
6	1	7,100	7,360	96	4	16	
	2	7,000		95	5	25	122
	3	8,000		109	9	81	
8	1	6,100	6,130	99	1	1	
	2	6,600		108	8	64	114
	3	5,700		93	7	49	
9	1	6,200	5,430	114	14	196	
	2	5,400		99	1	1	366
	3	4,700		87	13	169	
10	1	5,900	5,630	104	4	16	
	2	6,300		112	12	144	416
	3	4,700		84	16	256	
12	1	6,400	6,030	106	6	36	
	2	6,900		114	14	196	632
	3	4,800		80	20	400	
19	1	6,300	5,930	106	6	36	
	2	6,500		110	10	100	392
	3	5,000		84	16	256	
20	1	4,200	4,350	99	1	1	
	2	4,700		111	11	121	222
	3	3,840		90	10	100	
21	1	4,910	4,470	109	9	81	
	2	4,590		104	4	16	266
	3	3,920		87	13	169	
22	1	3,900	4,310	91	9	81	
	2	4,830		112	12	144	234
	3	4,200		97	3	9	
29	1	4,500	4,110	109	9	81	
	2	5,220		109	9	81	486
	3	2,620		82	18	324	

Pure line No.	Plot No.	Wt. of Gram in Grammes	Mean.	% Mean.	D.	D².	ΣD².
36	1	5,800	5,000	116	16	256	
	2	4,650		93	7	49	386
	3	4,550		91	9	1	
41	1	5,600	5,080	110	10	100	
	2	4,560		89	11	121	222
	3	5,090		101	1	1	
47	1	5,860	5,660	103	3	9	
	2	6,390		112	12	144	378
	3	4,720		85	15	225	
48	1	6,860	6,920	99	1	1	
	2	7,130		103	3	9	14
	3	6,760		98	2	4	
52	1	5,623	5,630	100	0	0	
	2	5,820		103	3	9	18
	3	5,450		97	3	9	
61	1	5,800	6,030	96	4	16	
	2	6,970		116	16	256	416
	3	5,320		88	12	144	
66	1	6,140	5,750	106	6	36	
	2	6,450		112	12	144	504
	3	4,670		82	18	324	
68	1	5,570	5,820	96	4	16	
	2	6,920		118	18	324	536
	3	5,980		86	14	196	
70	1	5,800	5,630	103	3	9	
	2	6,000		106	6	36	126
	3	5,080		91	9	81	
71	1	5,480	4,919	111	11	121	
	2	4,203		87	13	169	294
	3	5,040		102	2	4	
72	1	5,420	5,080	106	6	36	
	2	5,150		101	1	1	86
	3	4,720		93	7	49	
88	1	5,700	5,640	101	1	1	
	2	5,550		98	2	4	6
	3	5,690		101	1	1	
99	1	5,180	5,330	98	2	4	
	2	5,540		104	4	16	24
	3	5,270		98	2	4	

Pure line No.	Plot No.	Wt. of Grain in Grammes	Mean.	% Mean.	D.	D².	≤D².
172	1	4,780	5,260	90	10	100	
	2	5,880		111	11	121	222
	3	5,120		99	1	1	
186	1	5,730	5,910	97	3	9	
	2	5,930		100	0	0	18
	3	6,040		103	3	9	
192	1	6,090	6,200	98	2	1	
	2	6,680		108	8	64	104
	3	5,830		94	6	36	
203	1	6,260	5,730	109	9	81	
	2	6,180		108	8	64	434
	3	4,770		83	17	289	
208	1	5,060	5,000	101	1	1	
	2	5,870		107	7	49	114
	3	4,560		92	8	64	
211	1	5,140	4,920	104	4	16	
	2	5,230		107	7	49	186
	3	4,380		89	11	121	
218	1	5,530	5.020	110	10	100	
	2	5,520		110	10	100	600
	3	4,000		80	20	400	
232	1	5,540	5,190	107	7	49	
	2	5,610		108	8	64	338
	3	4,430		85	15	225	
238	1	5,280	5,060	103	3	9	
	2	5,570		110	10	100	278
	3	4,370		87	13	169	
247	1	5,910	5,410	109	9	81	
	2	5,850		108	8	64	434
	3	4,480		83	17	289	
254	1	5,120	5,500	93	7	49	
	2	6,620		120	20	400	618
	3	4,750		87	13	169	
257	1	5,870	5,880	100	0	0	
	2	6,440		109	9	81	162
	3	5,340		91	9	81	
262	1	5,570	5,320	105	5	25	
	2	5,600		105	5	25	150
	3	4,810		90	10	100	

Pure line No.	Plot No.	Wt. of Grain in Grammes	Mean.	% Mean.	D.	D².	ΣD².
105	1	5,550	5,470	101	1	1	
	2	5,740		105	5	25	62
	3	5,120		94	6	36	
112	1	4,690	5,090	92	8	64	
	2	5,530		109	9	81	146
	3	5,050		99	1	1	
113	1	4,700	5,080	93	7	49	
	2	5,400		106	6	36	86
	3	5,140		101	1	1	
114	1	4,050	4,620	88	12	144	
	2	5,370		116	16	256	416
	3	4,450		96	4	16	
119	1	5,250	5,030	104	4	16	
	2	5,110		102	2	4	56
	3	4,720		94	6	36	
123	1	4,970	5,010	99	1	1	
	2	5,170		103	3	9	14
	3	4,900		98	2	4	
140	1	5,800	6,400	91	9	81	
	2	6,330		99	1	1	182
	3	7,080		110	10	100	
150	1	5,460	4,780	114	14	196	
	2	4,520		95	5	25	302
	3	4,350		91	9	81	
151	1	5,490	6,010	91	9	81	
	2	5,690		95	5	25	302
	3	6,870		114	14	196	
161	1	4,490	4,690	96	4	16	
	2	5,260		112	12	144	224
	3	4,310		92	8	64	
167	1	5,450	5,620	97	3	9	
	2	5,690		101	1	1	14
	3	5,720		102	2	4	
169	1	4,840	5,330	91	9	81	
	2	5,720		107	7	49	134
	3	5,440		102	2	4	
170	1	4,100	4,810	85	15	225	
	2	5,260		109	9	81	342
	3	5,080		106	6	36	

Pure line No.	Plot No.	Wt. of Grain in Grammes	Mean.	% Mean.	D.	D².	≷D².
263	1	5,820	5,790	100	0	0	
	2	6,300		109	9	81	162
	3	5,250		91	9	81	
280	1	5,440	4,730	115	15	225	
	2	4,400		93	7	49	338
	3	4,840		92	8	64	
284	1	6,190	6,230	99	1	1	
	2	6,870		110	10	100	182
	3	5,620		91	9	81	
290	1	5,400	4,990	108	8	64	
	2	4,620		93	7	49	114
	5	4,950		99	1	1	
291	1	4,950	4,880	102	2	4	
	2	5,360		110	10	100	248
	3	4,330		88	12	144	
293	1	4,900	4,810	102	2	4	
	2	4,770		99	1	1	6
	3	4,750		99	1	1	
319	1	4,830	4,900	98	2	2	
	2	5,290		108	8	64	102
	3	4,580		94	6	36	
333	1	5,070	4,510	112	12	144	
	2	4,900		109	9	81	666
	3	3,563		79	21	441	
342	1	5,030	5,180	97	3	9	
	2	5,420		105	5	25	38
	3	5,088		98	2	4	
343	1	5,400	5,440	99	1	1	
	2	5,880		108	8	64	114
	3	5,050		93	7	49	
362	1	5,600	5,750	97	3	9	
	2	5,870		102	2	4	14
	3	5,780		101	1	1	
371	1	6,420	6,240	103	3	9	
	2	6,050		96	4	16	26
	3	6,250		101	1	1	
373	1	5,150	4,980	103	3	9	
	2	4,970		100	0	0	18
	3	4,[illegible]0		97	3	9	

Pure line No.	Plot No.	Wt. of Grain in Grammes	Mean.	% Mean.	D.	D^2.	ΣD^2.
524	1	4,990	4,500	111	11	121	
	2	4,420		98	2	4	206.
	3	4,090		91	9	81	
528	1	5,600	4,900	114	14	169	
	2	4,510		92	8	64	296
	3	4,590		94	6	36	
564	1	5,820	5,390	108	8	64	
	2	5,650		105	5	25	258
	3	4,690		87	13	169	
568	1	5,680	4,930	115	15	225	
	2	3,970		81	19	361	602
	3	5,140		104	4	16	
570	1	5,890	5,360	110	10	100	
	2	6,000		112	12	144	728
	3	4,200		78	22	484	
582	1	4,200	4,270	98	2	4	
	2	4,530		106	6	36	56
	3	4,090		96	4	16	
588	1	5,770	5,080	113	13	169	
	2	4,970		98	2	4	294
	3	4,490		89	11	121	
589	1	5,300	4,840	109	9	81	
	2	4,690		97	3	9	126
	3	4,540		94	6	36	
594	1	5,100	4,770	107	7	49	
	2	4,420		93	7	49	98
	3	4,780		100	0	0	
602	1	5,320	4,850	110	10	100	
	2	4,390		90	10	100	200
	3	4,840		100	0	0	
608	1	4,760	4,270	111	11	121	
	2	4,100		96	4	16	186
	3	3,960		93	7	49	
615	1	4,510	4,410	102	2	4	
	2	4,480		102	2	4	24
	3	4,220		96	4	16	
620	1	4,600	4,450	103	3	9	
	2	4,450		101	1	1	26
	3	4,290		96	4	16	

Pure line No.	Plot No.	Wt. of Grain in Grammes	Mean.	% Mean.	D.	D^2.	ΣD^2.
376	1	5,410	4,880	111	11	121	
	2	5,570		114	14	196	942
	3	3,660		75	25	625	
377	1	6,360	5,260	121	21	441	
	2	4,750		90	10	100	662
	3	4,680		89	11	121	
378	1	3,810	4,510	85	15	225	
	2	5,060		112	12	144	378
	3	4,650		103	3	9	
402	1	5,430	5,360	101	1	1	
	2	5,120		96	4	16	26
	3	5,520		103	3	9	
405	1	5,540	5,660	98	2	4	
	2	5,540		98	2	1	21
	3	5,890		104	4	16	
414	1	5,740	5,330	108	8	64	
	2	5,130		96	4	16	96
	3	5,120		96	4	16	
417	1	5,200	4,770	109	9	81	
	2	4,640		97	3	9	106
	3	4,470		96	4	16	
446	1	5,580	5,030	111	11	121	
	2	5,020		100	0	0	242
	3	4,480		89	11	121	
458	1	5,680	4,730	120	20	400	
	2	3,660		78	22	484	888
	3	4,840		102	2	4	
492	1	5,400	5,270	102	2	4	
	2	5,870		111	11	121	294
	3	4,530		87	13	169	
509	1	6,570	6,320	104	4	16	
	2	6,900		109	9	81	266
	3	5,480		87	13	169	
517	1	6,030	5,110	118	18	324	
	2	5,140		101	1	1	686
	3	4,160		81	19	361	
522	1	4,800	5,050	95	5	25	
	2	5,780		115	15	225	350
	3	4,560		90	10	100	

Pure line No.	Plot No.	Wt. of Grain in Grammes	Mean.	% Mean.	D.	D².	≼D².
629	1	4,300	4,320	100	0	0	
	2	4,680		108	8	64	128
	8	3,970		92	8	64	

$\Sigma d^2 = 22630$ $N = 90$ Total = 22,630

$$P.E. = \pm .67 \sqrt{\frac{22630}{89}}$$

$$= \pm .67 \sqrt{254.37}$$

$$= \pm .67 \times 15.95$$

$$= \pm 10.6865$$

$$= \pm 10.7\%$$

XVI.—IMPROVEMENT OF THE RICE CROP.

The idea of improving cereal crops seems to have originated during the first decade of the last century, though it was not until the last decade of the same century that any real progress was made. Improvement of grain crops can be effected in five ways (1).

(1) Amelioration of environment.
(2) Importation of seed.
(3) Mutation.
(4) Hybridization.
(5) Pure line selection of seed.

(1) *Amelioration of environment:* All cereal crops respond readily to improved methods of tillage or to any improved condition of the soil such as would be derived by the addition of manure. The fact that crops will grow at all depends on the law of the minimum, which demands that certain minimum amounts of nutrient substances shall be contained in the soil. For each crop there is an optimum condition of amelioration; for too luxurious conditions tend to develop vegetative growth at the expense of yield of grain, which is almost always the main object in growing cereals, but as far as local crops are concerned, there is little fear of over-cultivating the soil.

Improvement in the methods of water-control is the first concern in 'wet' padi cultivation. Following satisfactory water-control, additional tillage and the growth of green dressing plants with subsequent ploughing in of the organic matter would appear to offer most promise with the rice crop in this country from the view point of improving the texture of the soil as well as of increasing the proportion of nutritive material.

(2) *Importation of seed:* It sometimes happens that the variety of a cereal used in a district is found to yield unsatisfactorily and that seed imported from some other district or country where environmental conditions are somewhat similar, shows a distinct improvement. This has been proved with rice in the Federated Malay States, for selected Krian seed has been grown with marked success in several districts and in some cases, it certainly threatens to supersede the varieties cultivated previously. Importations may frequently show no immediate signs of success but, since all plants possess to some extent an inherent power of adapting themselves to their environment, they may in time become acclimatized and then prove better than the local types. Thus, a Japanese variety of rice which took seven years to become acclimatized to conditions in Italy now supersedes all other varieties on 250,000 acres in that country.

However, improvement of already acclimatized types is usually the better method to adopt, because no matter how much any kind of cereal seed is improved under one particular set of conditions, it may fail under even slightly different environmental conditione, to produce good crops, even after years of acclimatization.

(5) *Pure line selection :*—Pure line selection is by far the most important method of crop improvement and has developed along two lines, the one which may be said to have begun with the English breeder le Couteur, though this breeder was perhaps unaware of the extreme importance of his method, which may be described as that of "individual plant selection"; and the other known as "mass selection" being developed by several European breeders at about the same time. The latter method largely led up to the doctrine of evolution as propounded by Darwin, whose theory was that new species could be created by continued selection of individual variations. Later, de Vries' work on the nature of variation disclosed the imperfections in the scientific basis of this theory, so that it became less important; and the former method started by le Couteur, and independently discovered by Nilsson and elaborated in detail by the work of Johansson, Hays and others now holds the field.

Colonel le Couteur, a wheat breeder of Jersey, was visited about 1810 by la Gasca of Madrid who pointed out that his wheat cultures, though appearing of general uniformity, were of mixed nature and really consisted of a number of distinct sorts growing together. Le Couteur saved seed separately from individuals of the different sorts and tested the progeny of each. He found that the offspring bred pure to the type of the parent, each to each, and almost by instinct he did not seek to improve them further.

Similarly Sheriff, working on similar lines isolated the rare and exceptional plants in his cultures and sowing their seed separately, compared their progenies. He became eminently successful in isolating, multiplying and distributing heavy yielding types of wheats and oats. Though in his original experiments he took only the very exceptional plants for his cultures (and these were not easily discovered), he subsequently followed le Couteur's method of selecting a large number of types showing small differences and deciding on their utility by a comparison of their progenies.

This method has stood the test of time and the strong competition of the continental school, who considered that the English breeders were resting content with what nature had provided them, not availing themselves of the possibilities of continuous selection in the actual production of types theoretically conceived. The almost complete failure of the continental school and the complete vindication of the methods of the early English breeders form an extremely important chapter in the history of plant breeding.

The pure line method was independently discovered by Nilsson in 1892. Working at Svalof in Sweden he found that the number of failures that had to be recorded in the attempt at the production of types of preconceived forms by the process of continuous selection was enormous, but in that year he stated "I had occasion to observe here and there novel autumn wheats which at once opened interesting perspectives to me; they represented only 5 per cent of the whole collection. They showed uniformity and characteristic type such as we had never previously found in our plantings." These proved to be the productions of seed saved separately from individual plants.

(3) *Mutation :* In his study of this subject, de Vries (2) showed that, as is now generally accepted by biologists, variations are of two kinds, (a) fluctuating variations, which are due entirely to environmental influence and are not heritable and (b) discontinuous variations which arise unexpectedly and are due to sudden and unexplainable changes in the germinal substance of an organism. These latter variations which are of infrequent occurrence, but are always transmittable, are called mutations. Mutations are not due to any recognisable stimulus, nor can they be controlled. They appear fortuitously, and if they show any particularly desirable characters they have only to be maintained and developed as pure lines, in order to make that desirable character permanent.

Nevertheless, simple as this method of finding new races may seem, it is not favoured by breeders because, on the average, mutations do not appear to be of a progressive nature, indeed the records (3) of the chief cereal breeding station in Europe now seem to indicate that all mutations are retrogressive and that only characters formerly in existence arise in this manner, probably as the result of previous natural crossing in remote generations. If this is correct, it is of little importance to spend time in seeking for things which can be produced artificially and with much greater assurance of obtaining an advance.

(4) *Hybridization :*—Hybrid plants result from cross-fertilization between different strains of the same variety, or between different varieties. The laws which govern hybridization were first investigated by a monk named Mendel in 1865 although the value of his work was only appreciated in 1900, when the study of the problems which it solved became known as "Mendelism."

If a plant is regarded as being built up of a number of factors, each of which behaves as a separate and individual unit and each of which is transmitted as a unit from parent to offspring, then it is easy to understand that a hybrid is a new combination of the factors existing inherently in the parents which produced it. Thus a hybrid may differ from either or both of its parents in morphological or physiological characters, or in both respects, but it is almost always possible to reproduce the parental types of a hybrid by self-fertilizing it and then separating out the progeny systematically.

The hybridization method of improving cereals is important when it is required to combine in one strain, two or more desirable characters such as heavy yield and early maturity. Preliminary work on these lines is already in progress with rice in Malaya.

To be successful hybridization must follow pure line selection so that the practical values of the crossed varieties may be fully known. Crosses should always be made with a definite purpose in view, care being taken to avoid crossing sorts which are too dissimilar in character or are impure. After artificial crossing, pure line selection must be applied rigidly again in order to pick out the different types which have segregated out and to purify them prior to testing them on a commercial scale.

Since that discovery a colossal amount of experimentation has been executed and the results have been subjected to the most critical scientific analysis and from them the following points, which direct the methods of modern plant breeding, emerge.

Ordinary varieties of plants are built of many elementary forms. These forms may be distinguished by botanical or agricultural differences, or they may be of such a nature as to present neither of those distinguishing features, their differences being of a physiological nature ultimately distinguishable by chemical analysis. They have to be selected once, and then if the original selection is not of hybrid nature their constancy is assured as long as contamination is provided against.

Thus modern plant-breeding is rather of the nature of the isolation of the elementary species already present than of the creation of new species.

This method of plant improvement has been applied to rice in the Krian district of Perak where there is a continuous area of some 56,000 acres of irrigated rice land of which roughly 52,500 acres are planted annually with wet-rice. This being one of the largest and most important rice-producing areas in Malaya, the attention of the Department of Agriculture was turned early towards it as being the most promising for experimental work so that the main rice-breeding station was established at Titi Serong, some three miles from Parit Buntar, the administrative headquarters of the district.

This district produces annually an average of fourteen million gantangs of clean unhusked rice (padi) so that every 10% increase in production would mean over one and a quarter million gantangs of unhusked rice or sufficient to feed over ten thousand persons for a year.

An examination of the standing crop in this district showed clearly that each of the chief varieties of wet-rice was made up of a number of types differing in height, in robustness, in tillering power, in yielding capacity, in size of grain, in length of ear etc. A normal crop of a specified variety will yield on the average a certain weight of rice, but from such a crop it is possible, by selecting individual plants or preferably single ears, and by growing their progeny separately, to isolate a number of types or strains, each of which bears a distinctive character or characters. Some of these characters will be physiological, that is, will be indicated by the nature of the response to environment. If such as isolation of strains is effected and the grain of each strain is multiplied separately until there is enough to sow one acre of each, the yields of each will not equal the average for variety. Some will give more and some will give less than the average in such a manner that the sum of all the yields divided by their total number will equal the average for the variety. Clearly a direct and immediate increase of yield will be the result of such a selection if in future years, only the highest yielding strains are used for seed purposes; but it is also evident that the wider the selection of strains the more likelihood there is of obtaining the high results desired.

During the harvest of 1915-16, 300 strains of padi were selected from the heaviest producing areas in Krian and grown as pure lines. At the following harvest 1,000 more selections were added to these, making a total of 1,300 strains. In the first year a single ear of each of these strains was sown in the nursery and all the resulting seedlings were planted in a line varying in length according to the number of seedlings derived from each parent ear. In transplanting the seedlings into the fields only one plant was set to each hill, and a space of four feet was maintained between each strain (line). In each succeeding season the grain from a single plant only of each strain was used for seed thus ensuring the purity of the strains, while any strains which proved to be of hybrid nature were immediately eliminated.

All these strains were planted out as pure lines, in triplicate, for two successive seasons, before any elimination of the poorer ones could be made, owing to bad weather conditions and the great influenza epidemic which affected the cultivation of the crop very adversely in 1918. In each season since that date, approximately half the number of strains under trial has been discarded, so that in the season 1922-23 only 77 strains, representing five varieties were under trial. The following table shows the frequencies and the weights per plant in grammes as recorded during the last four seasons.

Weight per plant in grammes.	Frequencies. 1920	1921	1922	1923	Column 1 continued.	Frequencies. 1920	1921	1922	1923
25	1	2	1		85	93		2	9
30	1	6	1		90	86		1	11
35	1	9	3		95	51		1	11
40	2	14	1		100	10			9
45	5	21	6		105	6			7
50	6	52	7	1	110	5			3
55	14	61	11	1	115	2			1
60	21	39	18	1	120	1			1
65	18	31	21	2					
70	72	11	36	4	Total No. of strains	605	256	137	77
75	87	6	19	5					
80	90	1	6	8	Mean weight per plant	79	54	64	84

These are graphically portrayed in diagram C. The curves show that seasons 1920 and 1923 were good ones as evidenced by the high mean yields per plant. Seasons 1921 and 1922 were only fair, the former being the worst of the last four years. Giving due consideration to the vagaries of the seasons a gradual increase of the mean yield per plant is apparent. All those strains which showed an average weight per plant less than the mean weight per plant of all strains were eliminated in each season. The table below shows the annual average weights per plant of the best strains in each of the

chief varieties during the last five years, together with the average weight per plant of all the pure strains under trial and of padi grown from unselected seed,

Strain No.		1919	1920	1921	1922	1923	Average of 5 years.
Variety :—SERAUP KECHIL.							
36		95	108	80	71	117	94
52		93	113	74	70	115	93
48		85	102	69	85	120	92
68		87	111	68	77	111	91
20		86	113	73	64	109	89
257		88	119	67	82	87	89
371		87	101	73	75	107	89
146		86	103	76	79	96	88
6		85	95	71	76	107	87
8		79	97	65	79	104	85
151		83	98	68	76	99	85
517		80	95	67	69	98	82
Variety :—RADIN—BEST 6 STRAINS.							
7	Radin kuning	84	86	91	83	83	85
2	,, merah	72	81	92	86	75	81
13	,, puteh	81	79	91	69	80	80
1	,, merah	77	78	96	71	69	78
16	,, merah	75	79	85	74	75	78
4	,, merah	72	76	81	64	85	76
Variety :—SERAUP BESAR.							
15		82	106	76	58	101	85
509		75	93	58	82	93	81
3		76	97	64	54	98	78
590		70	97	74	61	82	77
Variety :—PADI PAHIT.							
1		75	86	78	78	101	84
4		72	84	81	80	91	82
8		69	83	92	75	83	80
7		71	78	73	63	85	74
Average yield from unselected seed		49	51	45	43	49	47
Average yield per plant from all selected strains		66	79	54	64	84	69

The yields per plant in each season were derived by weighing the produce of 100 plants of each strain. These 100 plants were grown in four separate lines of 100 plants each every season, each line being planted in a different part of the experimental area. The yields produced by unselected seed were obtained by harvesting 100 plants in 10 straight lines of 40 plants each in an adjacent field planted by a Malay.

The following selections have been made for additional trials and multiplication in season 1923-24 for distribution in season 1924-25; Seraup kechil Nos. 36, 52, 48, 68, 1; Radin puteh No. 13; Radin kuning No. [illegible]; Radin merah Nos. 2 and 4; Seraup besar No. 15 and Pahit No. 1. In anticipation of their heavy yielding capacities, each of the above selected strains has already been tested at the Titi Serong Experiment Station in half-acre plots during the past two seasons. They have also been tested in similar sized plots in various areas in the Peninsula.

Varying conditions throughout the country necessitated the trial of serveral strains in each rice growing district and though no attempt at the distribution of tested pure strains has yet been made, natural distribution has taken place in nearly all the areas where selected strains have been tested and the most suitable strain for many districts is already known.

Tests of pure strains in various areas can only, be carried out satisfactorily under control, because the cultivators prejudice in favour of the varieties which they have grown for many years and which they know will give them their normal crops, would lead them to use seed distributed broadcast for food or else to sow it on a small portion of the worst land in their possession, the best land being reserved for local varieties. Under these conditions the selected seed would probably produce smaller crops than the local variety and the cultivator would have proved to his own satisfaction the superiority of his own seed. Testing of pure strains has been most active in Perak North, thanks to the energy and enthusiasm of the Agricultural Inspector and his staff, (4) and it has been found that natural distribution of selected seed has taken place in the neighbourhood of many of the test areas. Thus, in the "mukim" of Kampong Lalang in the district of Kuala Kangsar, the Penghulu was given enough seed of the pure strain 'Seraup' No. 1 to plant a quarter of an acre of land in season 1921-22. "From his crop he distributed 35 "gantangs" of seed, (sufficient to plant 10 acres), to his friends who obtained the following yields which were carefully measured by an Agricultural Assistant."

Locality.	Strain.	Yield.	Locality	Strain.	Yield.
Kampong Lalang	S.I.	880 gantangs.	Bendang Ulu Papan	S.I.	650 gantangs.
" "	"	690 "	Paya Panjang.	"	750 "
" "	"	720 "	Kampong Star.	"	650 "
" "	"	775 "	Bendang Pulai.	"	645 "
" "	"	740 "	" "	Local seed	575 "

1 gantang of padi weighs approximately 5.25 lbs.

The yields tabulated above show that the soils in which the padi was grown must have been very good rice soils, but nevertheless the yields from the selected seed being substantially higher than those from the unselected seed, natural redistribution is bound to take place in this "mukim." The example quoted is the best on record from the point of view of actual yields but is typical of the course of events in the neighbourhood of numerous test areas except that in most cases the redistribution has been much more extensive. Thus, in the neighbourhood of the Krian Experiment Station it is estimated that not less than 1,500 acres were planted with selected seed during the last padi season though no effort was made to advertise the seed. In a similar manner pure line Radin 13 has made good at Talang in the "mukim" of Saiong. Seraup Nos. 36 and 52 and Radin Nos. 7 and 2 have earned favour amongst the cultivators in Krian. At Lubok Merban, Seraup 29 has established itself and Seraup 36 has proved itself in Bukit Gantang and Batu Kurau "mukims. The merits of Radin 2 are recognised in Larut Tengah and of Radin 7 in Province Wellesley. Radins Nos. 4 and 13 have spread considerably in Lower Perak and Radin Nos. 1 and 13 have proved good yielders in Malacca under adverse conditions. Good reports have been received of Radin 13 in Perlis and Tampin, and of Radin 2 in Alor Star and Radin 4 in Kota Bharu, and of other strains in various places.

A striking characteristic of nearly all the pure strains tested is the absence of empty grains on the ears. The fact that all selections were made by weight would probably account for this character as well as for the robust stand of the padi - another feature upon which comment has been made in several areas. Attention has been focused chiefly on two varieties, "Seraup" which has a maturation period of 7-8 months and "Radin" which normally matures in 6 months.

All 'wet' padi conditions in Malaya can be catered for by various strains of these two varieties of which populations comprising forty plants of each of the best twelve strains of each variety are compared in diagram D. The curves in this diagram are prepared from the following frequency tables

Groups Grammes	No. of Plants Seraup	No. of Plants Radin	Groups contd.	No. of Plants. Seraup	No. of Plants. Radin
7	1	6	112	70	50
22	7	12	127	41	30
37	22	15	112	16	14
52	45	66	157	2	2
67	78	72	Totals	480	480
82	103	91	Mean Weight per plant.		
97	95	92		86	78

The curves show that the eight months variety (Seraup) has a higher mean yielding capacity than the six months variety (Radin) or that there is a definite correlation between maturation period and yield in comparing these two varieties, though this correlation does not hold in comparing all varieties. The tillering curves (not represented) for the same populations are similar to the weight curves, the mean of the Seraup variety being 20.5 tillers as against 19.0 for the Radin variety. The chief features of Seraup Nos. 36 and 52 and Radin Nos. 7, and 13 are compared in the table below, the figures being the averages of numerous measurements.

	No. of grains per ear	Wt. per ear gramme	Length of ear cms.	Length of straw cms.	Length	Width	No. of tillers per plant.	Weight per plant.
Seraup 36	244	5.52	27.6	120	8 mms.	3.3mms.	21	94 gms.
" 52	231	6.70	31.8	150	9 "	3.3 "	23	93 "
Radin 7	295	5.51	30.5	115	7 "	3.0 "	20	85 "
" 13	236	5.40	27.8	120	7.9 "	3.0 "	20	80 "

It will be noticed that though S. 52 has heavier ears and more tillers per plant than S. 36, the latter is the better yielder under average agricultural conditions because of its robustness though the difference in yielding ability per acre is not more than twenty gantangs of padi. The Seraups are better than the Radins for milling purposes, the former averaging 63 per cent of rice (by weight) and the latter 60 per cent. Within each variety the various strains differ to a small extent in their milling qualities. It is quite impossible, on account of insufficiency of staff, to obtain any reliable information as to the extent to which Krian pure strains have already spread in the country or concerning the identity of the strains which have spread most in the various areas. In some areas strains are known to have been mixed somewhat though the composition of the mixture is on record in most cases, but this is unvoidable until large stocks of the best strains are available for general distribution in the districts to which they are most suitable. Multiplication of established strains is being arranged for the ensuing season so that stocks may be available for a scheme of general ditribution in season 1924-25 when an effort will be made to replace mixed strains by pure seed. Krian pure strains already form the bulk of the padi crop in several areas, though in most of these cases the strains have become somewhat mixed as in some of the "mukims" of Kuala Kangsar and Lower Perak, but it is hoped that this state of affairs will be remedied gradually when large stocks of pure seed become available. In conclusion, it may be expected that the use of selected pure strains will show increased average yields in various areas, the increases varying from five to twenty five per cent depending on local conditions and methods of cultivation.

1. Improvement of Cereals—H. W. Jack—Malayan Agricultural Handbook 1922.

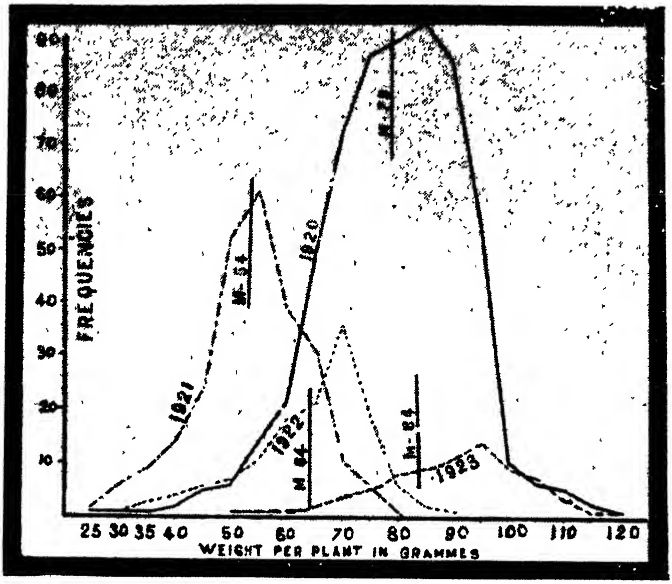


Diagram C:—Frequency curves of weight of all pure strains, 1920 to 1923.

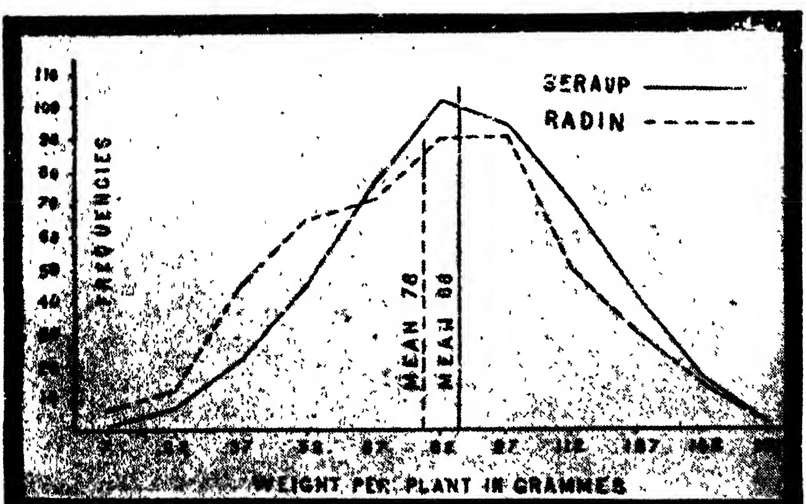


Diagram D:—Frequency curves of weight of populations of 480 plants of the Radin and Seraup varieties.

2. Species and Varieties, Their Origin by Mutation—Hugo de Vries 1906.

3. Plant Breeding in Scandinavia—L. H. Newman,—Canadian Seed Growers Association, Ottawa 1912.

4. Records of The Agricultural Inspector Perak North (unpublished.)

Received for publication 20th April, 1923.

FOOD PLANTS OF LEPTOCORISA, spp.

"PADI FLY." "RICE SAPPER." "PIANGGANG."

BY

G. H. CORBETT.

RECORDS and references concerning *Leptocorisa varicornis*, Fabr., *Leptocorisa acuta*, Thunb., or *Leptocorisa costalis*, Herr. Sch., in Malaya, relate for the most part to damage caused by both nymphs and adults to the grain of padi (*Oryza sativa*) when the seeds are in the milky stage, but information concerning alternative host plants is not given. An occasional remark that this insect feeds on grasses is found, but the species of grass is not mentioned.

Ridley (1), writing concerning *Leptocorisa acuta*, Thunb., states:—"What I take to be this insect is very common here in long grasses and I find it always on plants of *Panicum plicatum* grown in the Botanic Gardens."

Experiments conducted at Kuala Lumpur showed that *Leptocorisa* probably *costalis*, was capable of feeding and passing through its life cycle from egg to adult on the inflorescences of the following graminaceous plants:—

Panicum colonum, Linn.,
Paspalum conjugatum, Berg.,
Paspalum platycaula, L.,
Andropogon sorghum, (L) Brot.,
Eleusine coracana, Gaertn.,
Pennisetum typhoideum, Rich.,
and *Panicum crus-galli*, L.

The time taken for this insect to develop from the hatching of the egg to the adult stage varied on *Panicum colonum* from 17 to 19 days; on *Paspalum conjugatum* 17 to 23 days; on *Paspalum platycaula* 18 to 19 days; on *Andropogon sorghum* 16 to 17 days, on *Eleusine coracana* 25 to 26 days; on *Pennisetum typhoideum* 19 days and on *Panicum crus-galli* 17 to 19 days.

Newly emerged nymphs on *Eleusine aegyptiaca* Desf., died in 6 to 8 days; on *Panicum indicum*, L., in from 2 to 3 days; on *Eleusine indica*, Gaertn., in 4 to 6 days; on *Panicum maximum*, Jacq., in 3 to 6 days; on *Eragrostis amabilis*, Wight., in 2 to 3 days; on *Centotheca lappacea*, Desv., in 2 days; on *Ischaemum ciliare*, Retz., in 2 to 8 days; on *Fimbristylis* sp. (a), in 2 to 3 days; on *Cyperaceae* (b), in 2 to 3 days, and on *Cyperaceae* (c) in 3 to 4 days.

Lefroy (2) in addition to *Andropogon sorghum*, *Pennisetum typhoideum* and *Eleusine coracana*, records *Panicum frumentaceum* and *Setaria italica* as suitable for *Leptocorisa varicornis*. Leopoldo

Uichanco (3), in addition to *Panicum crus-galli* and *Panicum colonum*, records *Panicum flavidum*, Retz., *Panicum reptans*, L., and *Digitaria consanguinea*, Gaudich., as suitable grasses for the development of *Leptocorisa acuta*, Thunb., but found that *Andropogon sorghum* did not seem to provide suitable food material for this insect. *Leptocorisa costalis* (?) in the experiments at Kuala Lumpur thrived on *Andropogon sorghum*, and newly emerged nymphs developed to adults on *Paspalum conjugatum*, but in the Philippines *Leptocorisa acuta* died in the 3rd instar on this grass.

Grasses and sedges on which the nymphs died in a few days might be found agreeable to *Leptocorisa costalis*. Austin (1) in fact, working with *Leptocorisa varicornis* found that *Ischaemum ciliare*, *Eragrostis amabilis* and two species of *Fimbristylis* served as food plants. The writer found that on *Ischaemum ciliare* newly emerged nymphs of *Leptocorisa costalis* died in 2 to 3 days; on *Eragrostis amabilis* in 2 to 3 days; on a species of *Fimbristylis* in 2 to 3 days, and on two other *Cyperaceae* in 2 to 4 days. Besides these and *Panicum crus-galli* and *Panicum colonum*, Austin further records as food plants *Cyperus polystachus*, Rottb., *Fuirena umbellata*, Rottb., *Paspalum scrobiculatum*, L., and *Cyperus rotundus*, L.

In passing it might be mentioned that Green (5) in Ceylon records *Leptocorisa acuta* on rubber, and Maki (6) in Formosa, mentions it as a pest of minor importance on mulberry.

Though insufficient work has been carried out to state definitely the species of grasses which are suitable for the development of *Leptocorisa*, spp., observations both here and elsewhere show that certain species of grasses around padi areas provide nutriment for the development of nymphs to adults, and the time taken for the insect to reach maturity on some of them compares very favourably with the time taken on the ripening grains of padi.

The practice of allowing grasses to flourish during the padi season, and volunteer padi and grasses to spring up between padi seasons, should not be encouraged, as ideal breeding places for this insect are thus maintained.

Finding varieties or strains of padi immune or resistant to the attacks of *Leptocorisa spp.* by breeding or selection would be a considerable undertaking, but there is no doubt that some varieties of padi are less susceptible than others. Leopoldo Uichanco (3) records "Binicol" as a variety of padi preferred by *Leptocorisa acuta* to others, and Jack, Economic Botanist of this Department, is of the opinion that the variety of padi known to the Malays as "Padi pahit" ("Pahit" has reference to the bitterness of the glumes and not to the grain), is hardly ever touched by this insect.

Bearded varieties of padi with thick glumes and closely set spikelets would probably be more resistant than non-bearded varieties with thin glumes, and possessing an attractive odour.

Note.—a.b. and c. These Cyperaceae have not at present been identified.

Literature Cited.

1. 1900. Agricultural Bulletin of the Malay Peninsula, No. 9.

2. 1905. Memoirs of the Department of Agriculture of India Vol. 2 No. 1.
" The Rice Bug. *Leptocorisa varicornis*, Fabr."

3. 1921. Philippine Agricultural Review, Vol. XIV, No. 1. " The Rice Bug, *Leptocorisa acuta*, Thunb., in the Philippines."

4. 1922. Department of Agriculture, Ceylon, Bulletin No. 59. " A Preliminary Report on Paddy Fly Investigations."

5. 1916. Transactions 3rd International Congress, Trop Agric., London. " On some Annual Pests of the Hevea Rubber Trees.

6. 1916. Publication No. 90 of Formosa Government Agricultural Experimental Station.

Received for publication 14th May, 1923.

COVER CROPS AND THE SPREAD OF FOMES LIGNOSUS.

BY

F. BIRKINSHAW.

IN June 1922 advice was asked regarding *Fomes lignosus* attacks on an area of young rubber interplanted with *Centrosema plumieri* as a cover crop. It was stated that the cover crop appeared to assist the spread of the disease.

The area in question was burnt off in July 1919, cleared of timber, but not stumped, in the September following and planted towards the end of that year and early in 1920. The trees were contour planted. In September 1921 *Centrosema plumieri* was planted between the rows, the contour terraces on which the trees were planted being kept clean weeded. At the time of my visit the cover crop was growing luxuriantly and formed a very effective cover.

Fructifications of *Fomes lignosus* were found on several jungle stumps. In each of these cases the mycelium of the fungus was present in large quantities on the surrounding decaying vegetation formed by the cover crop as well as on the living stems of the crop. In no case seen was the cover crop killed by the fungus. It was clear that the fungus was spreading more rapidly than it would have done had the land been clean weeded.

It was decided to lay out an experiment to ascertain the possibility of controlling this disease by the determination of the number of jungle stumps infected and by isolating and treating each such infected area. Accordingly 500 jungle stumps were examined for fructifications of *Fomes lignosus*. Of these 22 were found showing the fructifications or a percentage of 4.4. These stumps were marked by means of red flags.

Three months later the same 500 stumps were again examined. On this occasion 24 fresh stumps were found developing *Fomes lignosus* fructifications, bringing the percentage of infection to over 9. In the majority of cases the fructifications on the 22 stumps originally marked had disappeared. It was clear therefore that no determination could be made at any one time of the number of infected jungle stumps by counting the number showing fructifications of the fungus. The idea of control on these lines was therefore abandoned and the complete stumping of the whole area recommended.

Received for publication May 19th, 1923.

THE TREATMENT OF A ROOT DESEASE OF BORNEO CAMPHOR

BY

F. W. SOUTH.

IN the Agricultural Bulletin of the Federated Malay States Vol. IX, No. 1. January, February and March, 1921 appeared an article entitled "An Important Root Disease of Borneo Camphor". This recorded the occurrence of attacks of the fungus *Rosellinia bunodes* (B. and Br.) Sacc. on the roots of trees of Borneo Camphor, "kapur" in Malay, (*Dryobalanops aromatica*, Gaertn.). These attacks occurred on small patches of land in the Kanching Forest Reserve, Selangor.

The treatment described in the article referred to above was carefully carried out during the first four months of 1921, the specimens of the disease having been sent to the Agricultural Department in the previous December. The work was done under the instructions of the Ag. Deputy Conservator of Forests, Selangor. On the conclusion of the work he submitted a report on the results obtained to the Director of Agriculture, from which he has kindly allowed the following information to be taken.

During the four months, January, February, March and April in which the work was in progress, a total of 393 trees were treated. The cost of the work was as follows:—

Wages	... ...	$274.75
Lime	... ...	17.50
Repairs to Tools	...	17.00
Total	...	$309.25

This gives an average of 79 cents per tree which is perhaps somewhat high. It must, however, be considered that the attacked trees had to be searched out over a very steep forest-clad hill and that lime had to be carried up to the infected patches, all without European supervision. As no further cases were found after the end of April, the results appear very creditable to the local staff of forest officers.

The "Sanitary squad" employed on this work was retained throughout May in order to search the whole Reserve for new attacks, or for any that might have been missed. None were found. The additional wages brought the total expenditure on the elimination of the disease to $357.75.

It was found that the attacks were fairly uniformly distributed in each compartment of the Forest Reserve and roughly corresponded in density to the density of the regeneration.

The main features of the treatment recommended were:—That the infected areas should be isolated by a trench 2 feet deep and 1 foot wide placed so as to include a margin of apparently uninfected soil 2 or 3 feet wide round each area.

That all the diseased plants inside the trench should be dug up and burnt, with as much as possible of the surface cover of leaves and twigs.

That each patch should be well limed, at the rate of 2 tons per acre, and should be well forked over, all bits of wood in the soil being removed and burnt.

In practice it was found that a much smaller area needed to be trenched than was expected, in fact that 3 feet radius from the attack was sufficient. It was also found that the virulence of the pest was perhaps over-rated, or the efficiency of lime under-rated, because in many cases seedlings growing inside a trench continued to be quite healthy.

No further attacks have been reported to the Agricultural Department since this treatment was undertaken.

Received for publication 16th May, 1923.

JELUTONG.

BY

B. J. EATON & J. H. DENNETT.

SINCE there do not appear to be many recorded analyses of jelutong in the literature on rubber etc. the following results of analyses of samples examined recently in our laboratories are placed on record. The results must be regarded as incomplete, since they show only rubber, resin, moisture and ash, while the rubber content is determined by difference, and the "resin" represents the acetone extract. It is possible that jelutong contains nitrogenous substances, like the rubber from Hevea and other latices, but no determination of the nitrogen content has been made.

Description of Samples:—The following samples were received and investigated:—

(1) Jelutong latex.
(2) Crude jelutong prepared by Chinese.
(3) Crude jelutong prepared by native methods.
(4) So called purified jelutong.

(1) *Jelutong Latex:*—This consists of a white emulsion similar in appearance to Hevea latex. It can be coagulated with acetic acid or alum and also anaerobically by placing it in sealed vessels. Anaerobic coagulation yields a coagulum which has no unpleasant odour even after standing for several days and this indicates that the amount of organic nitrogenous matter present must be very small.

The crude coagulum prepared from this latex contained 75.5 per cent of moisture and the dry coagulum contained 79.3 per cent of "resin." The total solids in 100 ccs. of the latex (78.4 grams.) amounted to 18.2 per cent and contained 79 per cent of "resin."

The weight of the dry coagulum from 100 ccs. of latex was 17.6 grammes, equivalent to 22.5 per cent by weight.

(2) *Chinese Jelutong:*—This consisted of a compact coagulum.

(3) *Native Prepared Jelutong:*—This sample had a honeycomb structure and was sticky and discoloured.

(4) *"Purified" Jelutong:*—This sample was of a greyish white colour and gummy in character.

Results of Analyses:—The results of analyses are summarised in the table attached.

Remarks and Conclusions:—The results obtained do not indicate any marked difference between the samples of jelutong prepared by different methods, except in respect of the moisture content, which

probably depends largely on the freshness of the material. The moisture content of the Chinese sample is high.

The "resin" content varies from 75.9 to 80.9 per cent on the dry product and the "rubber" content from 19.1 to 24.1 per cent, depending on the "resin" content.

The ash in all the samples is low which indicates that none of the samples have been adulterated by the addition of inorganic or mineral substances.

The so-called purified jelutong has the lowest "resin" content and highest rubber content, which may be due to removal of acetone soluble substances during purification.

The results confirm previous available analyses.

Notes :—The following extract from a translation of "De Nuttige Planten van Nederlansch-Indie" by K. Heyne published in 1917 are of interest in connection with this product.

"The jelutongs are scattered trees growing to enormous sizes and are among the tallest of jungle trees. The largest specimen seen by Van Romburgh had a circumference of 24½ feet and a height estimated at 150 feet. Wechel (Teysmannia 1911, p. 153) gives the diameter as 3 to 6.5 feet and height of trunk to first branches as 100—165 feet. The trunk is usually very straight and the crown close.

In Borneo the Dyaks distinguish three varieties, the white and black, growing in swamp lands and the red growing in the hills. The last named however is stated to yield very little latex. The white and black varieties refer to shades of bark.

Ridley (Straits Bulletin 1903, p. 96) describes the wood as soft, white and not durable. It is used for making boxes, planks, models, Chinese shoes and recently for the manufacture of match sticks.

The tree belongs to the genus Dyera and there are probably several species. In Malaya, *D. Costulata* and *D. Laxiflora*, the former having a reddish bark when cut and the latter a whitish bark. The former is said to contain much more juice than the latter. Both species grow scattered in the valleys and on the hills in Malaya to a height of 500 feet or more, but seldom in swampy land.

Tapping :—Te Wechel (l.c.) describes the method of tapping in Borneo as follows:—Four, five or six cuts are made round the tree, as broad as a hand, right to the wood, and 4½ feet above the ground. On returning about the eighth day the wounds are enlarged, to the breadth of about 3 fingers, with a parang. The enlarging of the wounds to the right and left is stopped when the wounds almost touch each other. The tapping is continued downwards to the ground and higher up the tree as far as the parang will reach.

The first exudation of watery liquid is discarded. but that which appears after about five minutes coagulates on the tree to a thick milk.

The above method of tapping results in the death or destruction of the trees. Trees were exploited later in Malaya, Sarawak and Borneo under European control, chiefly by the company known as the United Malaysian Coy. and two subsidiary companies, all since defunct.

The method of tapping employed was to cut a long V with a channel from the base of the V leading to the collecting cup. The production of latex and the recovery of the trees was said to be good. Trees were however killed by tapping, owing to the difficulty of supervising the native tappers. No systematic tapping is however being carried out at present, although at least one European is collecting jelutong in Pahang and Kelantan.

Preparation :—After tapping and collection, the collector adds about one-third water to the milky juice collected to prevent fermentation and coagulation. The latex is then poured into a basin, diluted with three parts of water and 1/8 bottle of paraffin and a little ground "obat pantung" (Note:—In the Straits Bulletin 1903, 191, a recipe for the preparation of jelutong is given, in which paraffin and "plaster" are used as coagulants, also alum.)

The mixture is stirred for about 2 hours and then left till the following morning, by which time coagulation has taken place and the water not absorbed by the coagulum is poured off.

The coagulated jelutong is treated repeatedly with hot water and then rolled with a bottle. A block weighing 28—30 katies is prepared and kept in a stream. Te Wechel considers that the jelutong thus obtained weighs about three times the weight of the juice collected, due to absorption of water. A large tree is said to yield ½ picul of juice and trees of medium size can be tapped for about a year.

Market Products & Uses :—The name jelutong has superseded the old names "Dead Borneo" or "Pontianak." The product consists of caoutchouc, resin and water. Material from Palembang, free from water and dirt, was found to contain 21.3 per cent of caoutchouc and 78.5 per cent of resin while a sample from Pontianak yielded 22 per cent of caoutchouc and 78 per cent of resin. The former crude sample contained 18.9 per cent of water and the latter 27.2 per cent of water. The difference in value of samples of jelutong of different origins are probably due chiefly to varying percentages of water. The product usually appears on the market in blocks, having the consistency of putty and containing water. The exterior of the block is usually greyish while, white the inside is white. The product has a peculiar acrid odour.

Palembang jelutong is said to contain most caoutchouc (15—18 per cent) followed by Bandjermasin (12—14 per cent) and finally by that from Pontianak.

Our figures show the samples examined to be of high quality in respect of caoutchouc content.

Jelutong, which is not kept under water, is said to deteriorate quickly.

It will be remembered that during the early days of the rubber industry when raw plantation rubber was fetching a high price, the United Malaysian Coy. erected extensive factories for the extraction of the resin from jelutong and marketed a product containing over 90 per cent of caoutchouc.

Little information is avaliable as to the commercial uses. It is probably used to some extent in rubber manufactories for shoes and other articles and is also stated to be used in asbestos, celluloid and linoleum factories. According to Ridley (Straits Bulletin 1903, page 95) it is used largely to make architectural work water tight.

TABLE.

	Jelutong latex.	Fresh Jelutong from latex.	Chinese Jelutong.		Native Jelutong.		Purified Jelutong.	
			Fresh Sample.	Dry Sample	Fresh Sample	Dry. Sample.	Fresh Sample.	Dry Sample.
Total Solids (%)	18.2	24.5	52.9	...	82.3	...	82.1	...
Moisture (%)	...	75.5	47.1	...	17.7	...	17.9	...
Ash (%)	...	...	0.05	...	trace	...	0.36	...
Resin (%)	...	79.0*	42.2	80.5	67.3	80.9	62.3	75.9
Rubber (%) by difference.	...	21.0*	10.7	19.5	15.0	19.1	19.4	24.1

* These figures represent "resin" ex-rubber content calculated on the dry coagulum.

Received for publication 15th May, 1923.

ROSELLE SEED OIL.

BY

C. D. V. Georgi.

AN investigation has recently been carried out to determine both the oil content of Roselle seed—*Hibiscus Sabdariffa* var. *Altissima*—and the characteristics of the oil.

Although it is extremely unlikely that surplus supplies of this seed will ever be available for oil expression, seeing that this plant is cultivated primarily for its fibre and for this purpose is cut down before the seed forms, it was considered advisable to have the figures for the purposes of record.

The seed was obtained from Mr. E. Mathieu, Superintendent Government Plantation, Kuala Kangsar, who made the original suggestion.

Oil Content.

The results of the analysis of the sample of seed were as follows:—

	per cent.
Moisture	12.9
Oil (Chloroform extract)	16.8
Residue (by difference)	70.3
Nitrogen	3.29
Oil (calculated on dry seed)	12.3
Nitrogen (calculated on dry oil-free residue) ...	4.68

Characteristics of Oil.

The results of the determination of the constants of the oil, which was expressed from seed in a small laboratory hand-press, were as follows. The figures for Kapok seed oil and Cotton seed oil are added for purposes of comparison.

The oil, when freshly expressed, was clear, brownish yellow in colour, with a sweetish sickly smell. There was a slight deposit of white sediment on standing.

Oil	Roselle Seed Oil.	Kapok Seed Oil.	Cotton Seed Oil.
Density at 15.5°C. ...	0.923	0.918	0.923
Refractive Index at 20°C. ...	1.4715	1.4710	
Saponification value ...	193.1	191.0	193.0
Iodine value (Wijs) ...	107.3	94.8	110.0
Acidity (Oleic Acid per cent)	2.2		
Unsaponifiable (per cent) ...	1.1	0.8	0.9
Fatty Acids.			
Solidifying Point (Titer value)...	28°C	28.4°C	35°C
Mean Molecular Weight ...	282.4	284.3	

Results of Experiments.

These experiments show that this variety of Roselle seed contains about 17 per cent of an oil, which is very similar to both Kapok seed and Cotton seed oils and could doubtless be used for the same purposes as these oils.

The residue remaining after the expression of the oil is rich in albuminoids, the nitrogen content of the dry residue being about 4.7 per cent., corresponding to about 29 per cent of albuminoids.

Received for publication 30th May, 1923.

SODIUM SILICATE IN SOAP MANUFACTURE.

IN connection with investigations of locally manufactured soaps which are being carried out in the Chemical Division of the Department of Agriculture, it has been ascertained that sodium silicate is being used by at least one local firm.

The following information on the use of this substance, abstracted from "The Chemical Trade Journal and Chemical Engineer" (Vol. LXII No. 1872 of the 6th April 1923) is therefore of interest.

Within recent years the practice of incorporating varying amounts of sodium silicate in common household soaps has become widely diffused, more especially in the United States.

The use of the silicate make possible the production of an attractive bar of soap and contributes to the general lowering of prices, not only on account of the reduction of the true fatty acid content of the soap, but also because the manufacturer can utilise oils which melt at low temperatures and yet obtain soaps containing large quantities of the valuable sodium oleate which will not dissolve too readily when subjected to the conditions of the household washboard.

As in the case of sodium carbonate and other alkalis, sodium silicate has a positive detergent action when used in soap and its function is not merely that of a filler or adulterant. The fact that soaps containing silicate do not "bloom" would not in itself be sufficient to justify the higher price paid by the soap maker for this substance, but in practice it has been found to have a greater value than sodium carbonate.

Although much information on this point has not been available hitherto, reseaches conducted recently by two large Americans firms (Vide Industrial and Engineering Chemistry March 1923) fully justify on scientific grounds the predilection of soap makers in favour of sodium silicate. Prior to 1903 almost all theories of the detergent action of soaps were based on the belief that the alkali formed by the hydrolysis of the soap was the active agent in washing.

Since that date, due to researches chiefly by Donnan in England and Hillyer in America, it has been recognised, that although factors such as wetting, lubrication, defloculation, solution and lathering contribute to detergent action, the power of effecting emulsification in the dominant factor.

It has now been found by American workers that sodium silicate improves the emulsifying power of a true soap to a far greater extent than sodium carbonate. This is particularly true when the silicate possesses a high ratio of silica to soda.

If the concentration of the silicate be not over 20 per cent., the suds formed are also stabilised. The effect of hard waters on soaps containing sodium silicate has also been investigated and it has been found that lime or magnesium compounds in such waters may be precipitated either as fatty acid salts, or silicates.

The conditions governing the proportions formed are complex but it has been estalished that at 100°C the water softening action of the silicate is very pronounced and results in a distinct saving of the true soap.

It does not appear probable that the silicate possesses any marked detergent properties, but that the increased emulsifying powers conferred on the soap produce the apparant detergent action.

The work has shown that silicated soaps have a quite legitimate place in household laundry work.

B. J. E.

Received for Publication 11th May, 1923.

MARKET PRICE LIST 2nd QUARTER 1923.

		London.		New York (In dollars gold.)	
Oil Seeds.					
Castor	-	£22	per ton		
Coconut, desiccated	-	£43.10-£45.5	,,		
Copra	-	£30	,,		
Cotton	-	£10-£11	,,		
Gingelly	-	£24-£25	,,		
Groundnuts, undecorticated	-	£17-£18	,,		
Groundnuts, decorticated	-	£23-£24	,,		
Linseed	-	£22	,,		
Palm kernels	-	£20	,,		
Oils.					
Castor	-	£53-£54	per ton	14½-16 cts.	per lb.
Coconut	-	£48-£50	,,	9-11¼ ,,	,,
Cotton seed	-	£41-£45	,,	10½ ,,	,,
Croton	-			$1.00-1.10	per lb.
Gingelly	-			96 cts.	per gallon
Groundnut	-	£45	,,	15½ cts.	per lb.
Linseed	-	£50	,,	$1.17	per gallon
Palm	-	£39-£42	,,	9 cts.	per lb.
Palm kernel	-	£45	,,	9½ cts.	,,
Oil Cakes.					
Coconut	-	£7.15-£8.5	per ton		
Groundnut, semi decorticated	-	£10.10	,,		
Groundnut, undecorticated	-	£8.10	,,		
Linseed	-	£10.15	,,		
Palm kernel	-	£5	,,		
Essential Oils.					
Cajeput	-	3/10-3/11	per lb.	80 -85 cts.	per lb.
Camphor, crude	-	3/-	,,	72 -73 ,,	,,
Camphor, refined	-	3/6	,,	90 -92 ,,	,,
Camphor, oil	-	82/6	per cwt.	11½-15 ,,	,,
Cananga	-	9/-	per lb.	$2.25-2.50	per lb.
Cinnamon, bark	-	3/-	per oz.	$12-15	,,
Cinnamon, leaf	-	4d	,,	$2.00	,,
Citronella, Ceylon	-	3/2	per lb.	70-74 cts.	per lb.

	London.		New York (In dollars gold.)	
Citronella, Java -	4/- 4/3	per lb.	85-87½ cts.	per lb.
Clove -	7/- 7/3	,,	$1.75-1.95	,,
Ginger -	23/-	,,	$5.75-6.00	,,
Lemon grass -	2¾d	per oz.	80-85 cts.	,,
Lime, expressed -	7/-	per lb.	$1.70-1.80	,,
Lime, distilled -	3/3 - 3/6	,,	60-65 cts.	,,
Nutmeg -	4/6	,,	90 ,,	,,
Patchouli, leaves -			22-25 ,,	,,
Patchouli, Penang -	29/- 30/-	,,	$8-8.50	,,
Vetiver, Bourbon -	20/-	,,	$5.50-6.00	,,
Ylang Ylang, Manila -			$30.00-40.00	,,

Spices.

Capsicums -	40/- - 70/-	per cwt.	14½-17 cts.	,,
Chillies -	100/- - 150/-	,,	27-30 ,,	,,
Cinnamon -	7½d - 10½d	per lb.	20-22 ,,	,,
Cloves, Zanzibar -	1/-	,,	26-27 ,,	,,
Cloves, Penang -	3/-	,,		
Ginger, Jamaica -	190/- - 230/-	per cwt.	37-41 ,,	,,
Ginger, Japanese, Cochin -	60/- - 65/-	,,	15½-16 ,,	,,
Mace -	1/5 - 1/8	per lb.	38-47 ,,	,,
Nutmegs, 110's -	10½d	,,	24-25 ,,	,,
Nutmegs, 80's -	1/1½	,,	26-27 ,,	,,
Pepper, black -	4¼d	per lb.	11-11½ ,,	,,
,, white -	6½d	,,	14-14½ ,,	,,
Turmeric -	40/- - 50/-	per cwt.	7-9½ ,,	,,

Drugs.

Areca Nut -	37/6	,,	9 ,,	,,
Coca, leaves -			40-45 ,,	,,
Cocaine, hydrochloride	14/9	per oz.	$7.07-7.50	per oz.
Ipecacuanha -	6/9 - 7/-	per lb.	$1.80-2.00	per lb.
Papain -			$2.15-2.25	per lb.
Quinine sulphate -	2/3	per oz.	50 cts.	per oz.

Natural Dyestuffs and Extracts.

Annatto, fine -			26-29 cts.	per lb.
,, seed -	8d	per lb.	6-7 ,,	,,
Cutch, Borneo, solid -	28/6 - 29/6	per cwt.	4¾-5½ ,,	,,
Gambier, block -	47/6	per cwt.		
,, cubes -	62/6 - 65/-	,,		

Gums.

Damar -	30/- - 150/-	,,	32-34 cts.	per lb.
Dragon's blood, reeds -	£18-£20	,,		

	London.		New York (In dollars gold.)	
Dragon's blood, lump -	£11-£28	cwt.		
Fibres.				
Cotton, American -	15½d	per lb.		
Cotton, Egyptian, Sakellaridis -	17d	,,		
Hemp, African sisal -	£36	per ton		
,, Manila -	£33.10	,,		
,, New Zeland -	£32.10			
Kapok, Java -	1/2 - 1/7	per lb.		
,, Indian -	10d - 1/-	,,		
Foodstuffs.				
Cocoa, Ceylon, plantation -	78/-	per cwt.		
Coffee, East India "B" size -	85/- - 100/-	,,		
Sago, pearl -	24/- - 30/-	,,		
,, flour -	16/- - 17/-	,,	4½-5 cts.	per lb.
Sugar, West Indian crystal -	58/6 - 60/-	,,		
Tapioca, flake -	8¼d - 4½d	per lb.		
,, flour -	18/- - 22/-	per cwt.	4¼-7 ,,	,,
Miscellaneous Chemicals.				
Acetic, acid glacial -	£70	per ton	$12-12.30	per 100 lbs.
,, ,, 80% comml	£47	,,	$9-9.30	per 100 lbs.
Acetone -	£125	,,	22½ cts.	per lb.
Ammonia -	£32-£34 (.880)	,,	7-7½ cts.	per lb. (26°.)
Calcium acetate -	£19-20	,,	$3.50	per 100 lbs.
Citric acid -	1/8½d	per lb.	49-54 cts.	per lb.
Creosote -			50-55 ,,	,,
Cresote oil -	10½d	per gallon	20-22 cts.	per gallon
Formalin -	£87	per ton	15-15½ cts.	per lb.
Lime juice, raw, clarified -	2/6-2/9	per gallon	50-60cts.	per gallon
Lime juice, concentrated -	£22	per basis[1]		
Sodium bisulphite -	£21-£23	per ton		
Sodium sulphite, anhydrous -	£28	,,		
Wood alcohol, 97% -			$1.12-1.17	per gallon

N.B.—1 American Gallon = .833 Imperial Gallon.

[1] Basis = 108 gallons, 64 ozs. Citric Acid per gallon.

NOTE.

Suckers of Sisal hemp *(Agave rigida var. sisalana)* can now be supplied in large quantities. Price $2/- per 100. Application for same should be addressed to the Agriculturist, S.S. and F.M.S.

ERRATA.

Vol. XI, No. 5, p. 105 line 2 *for* 5 acres *read* ·5 acres
107 line 7 *for* unusually grown in localities there *read* usually grown in localities where.

Vol. XI, No. 6, p. 141 Table VII Total average yield per annum *for* 13,991,280 *read* 149,860,280.

THE

Malayan Agricultural Journal.

Vol. XI. October, 1923. No. 10.

PREFACE

TO

REPORTS OF HEADS OF DIVISIONS.

By

A. S. HAYNES.

In para: 75 of my Annual Report on the Department for the year 1922 the following is written:—

> "I have been much struck by the interesting and informative annual reports written by some of the Heads of Divisions. To incorporate their reports in this one would render it unduly bulky and would impose on the general reader much detailed information on various aspects of agriculture which are rather special than general. Yet some of the reports contain records of investigations and reviews of work done which should be on record and should be available to those sections of the public who are particularly interested in their several lines. and a perusal of them will illuminate the usefulness and value of the work performed by the various Divisions of the Department, work which by its very nature cannot be brought to the notice of the public day by day.
>
> It is proposed therefore to make a new departure by printing these reports in the Malayan Agricultural Journal, the monthly organ of the Department".

Those words explain the appearance of these reports.

The latter speak for themselves; but it is not inopportune to draw attention to the large volume of valuable work done in connection with rubber and rubber research, revealed more particularly in

the reports of the Agricultural Chemist, the Mycologist, and the Plant Physiologist. The facilities at the offices of the Department which exist for the rubber planter in the vulcanising factory for rubber testing are not perhaps adequately realised : . to planters it is a great convenience to be able to bring their rubber to the factory, have it tested and reported on and discuss the results when available with the Agricultural Chemist on the spot.

I cannot leave the subject of these reports without mentioning the fact that the very valuable work done on padi has been summed up recently in an article "Rice in Malaya" by Mr. H. W. Jack, which appeared in the May-September issues of the Malayan Agricultural Journal, 1923 (Vol: XI Numbers 5-9 inclusive) and which is now being printed as a Special Bulletin.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST FOR 1922.

By B. J. Eaton.

Staff.—The Senior staff consisted of the following Officers :—

B. J. Eaton	...	Agricultural Chemist.		
R. O. Bishop	...	Assistant Agricultural Chemist.		
C. D. V. Georgi	...	,,	,,	,,
V. R. Greenstreet	...	,,	,,	,,
J. H. Dennett	...	,,	,,	,,

From January 1st to February 8th the Agricultural Chemist was acting as Director of Agriculture during which period Mr. R. O. Bishop acted as Agricultural Chemist.

Five Malay Officers have been attached to the Chemical Division as Assistants; additional subordinate staff and coolies in the Experimental Paper-making Factory are under control of the Chemical Division.

Organisation.—The Agricultural Chemist has been engaged almost entirely on administrative duties and the compiling of reports in connection with enquiries of a varied nature.

Mr. R. O. Bishop has been in direct charge of all investigations on rubber, paper investigations and examination of fibres.

Mr. C. D. V. Georgi has been in charge of all investigations on oils and fats, essential oils, forest products, lime fruit products and other miscellaneous investigations.

Mr. V. R. Greenstreet has been in charge of investigations on soils and fertilisers and various miscellaneous investigations.

Mr. J. H. Dennett has been in charge of all investigations in connection with the production of alcohol and sugar from Nipah Palm, including experimental tapping of the palm, work on coconut toddy, sugar cane, copra, desiccated coconut and other miscellaneous investigations.

In spite of the fact that the present staff is complete for the first time since this staff was authorised in January 1914 much work awaits investigation in many directions.

Malaya-Borneo Exhibition.—Almost the whole of the first three months, including much time outside office hours, was spent by the Chemists in the preparation of exhibits for the Agricultural section of

the Malaya-Borneo Exhibition. These included raw and vulcanised rubber, paper pulp, paper and cardboard from various local raw materials, lime fruit products, sugar and alcohol from various local raw products, vegetable oils and fats, essential oils, fibres, soil samples, peat and peat products.

The opportunity was taken to examine many of the prepared products for record and future possibilities. The officers of the division also contributed to the Handbook of Malayan Agriculture.

Rubber Investigations.

The principal investigations during the year have been the following:—

(*a*) The effect of storage of raw rubber on quality after vulcanization.

(*b*) The cause of the variability of sulphur on vulcanisation.

(*c*) The effect of cinchona alkaloids (especially the bye-products from the manufacture of the crystalline cinchona alkaloids) on vulcanisation.

(*d*) The effect of alum on raw rubber.

(*e*) Further investigations on "slab rubber."

(*f*) Investigation of Singapore Blanket crepes prepared from native sheet.

(*g*) The manufacture of rubber floor tiles.

(*h*) The variation in quality of rubber from tapping of individual trees.

(*j*) The non-caoutchouc constituents of latex.

(*k*) The preservation of latex for shipment.

The following observations in connection with the above investigations are of interest.

(*a*) Raw rubber, especially sheet and crepe, deteriorate on storage in this country. This has been noted in our investigations previously.

(*b*) Although there may be other causes for the variability of sulphur in its effect on the vulcanisation process, it has been discovered that a very small proportion of arsenious and arsenic oxides and other arsenic compounds have a very marked effect on vulcanisation. The problem of variability of sulphur has been attacked from the point of view of impurities in sulphur and other chemicals used

in the preparation of raw rubber and the manufacture of rubber goods and it is possible that impurities other than arsenic may be responsible for variability. It has also been found that certain soluble organic arsenic compounds may be of commercial value in this connection. It is of interest to note that, as far as our information goes, this effect of arsenic has not hitherto been recorded. The opposite effects of different quantities is also of interest.

(*c*) The investigation of the effect of the cinchona alkaloids, especially the non-crystallisable alkaloids remaining in the extract of the bark after the extraction of the crystalline alkaloids—quinine, cinchonine, cinchonidine and quinoidine, was carried out as a result of tests on a product given to the writer while on leave in 1921, which was stated to be used in rubber works. The product is almost certainly quinoidine which is the commercial name applied to the mixture of amorphous alkaloids from cinchona bark, which were not used previously to any extent, as far as the writer is aware. It has since been found that quinoidine is used in America as a vulcanisation accelerator.

(*d*) A further report has been compiled, but not yet published, on the effect of the addition of the alum to dry raw rubber.

(*e*) Investigation on the drying of "slab" rubber prepared and dried under different conditions has been commenced and is in progress.

Since the standard laid down for this grade for Customs purposes is a moisture content of 20 per cent, it is necessary on economical grounds for estates to export slab rubber containing not more than this amount.

Enquiries have also shown that native rubber exported from Perak and sold chiefly by small holders to local rubber dealers is essentially slab rubber. One large Company has exported considerable quantities of this grade of raw rubber during the year but chiefly in the form of dry crepe prepared by machining the matured coagulum and subsequently drying.

(*f*) An investigation of Singapore Blanket crepes from native sheet indicate considerable variations in the quality of these grades due to the use of alum as a coagulant in the Colony.

(*g*) Advice and assistance has been rendered in connection with the manufacture of rubber floor tiles.

(*h*) A report on the quality of rubber from the tapping of individual trees will be prepared shortly.

(*j*) An investigation in conjunction with the Plant Physiologist of the non-caoutchouc constituents of latex and their effect on the quality of rubber during vulcanisation, is in progress.

(*k*) In view of the great interest which is being taken in the export of latex, for the manufacture of latex paper, impregnation of fabrics, cords for tyres, etc., investigations on the preservation of latex with ammonia in the form of a strong solution of ammonia, liquified anhydrous ammonia gas and with other preservatives have been carried out and are being continued.

There appears little doubt that at present for most purposes, ammonia is preferred, although several other substances or combination of two substances are more economical and equally effective for certain purposes. A paper on the use of ammonia has been published in the Malayan Agricultural Journal and another paper has been prepared in connection with other preservatives. Advice in the form of reports and visits, including personal supervision, has been given to a number of estates in this connection. An article on "whole" rubber or desiccated latex has been prepared for publication in the Malayan Agricultural Journal.

Rubber manufacture.—The local manufacture of rubber goods in Singapore appears to be increasing and one firm is manufacturing large numbers of soles for boots and shoes and also complete canvas boots and shoes with rubber soles.

New methods of preparation.—Slab rubber continues to be prepared on two or three estates for certain consumers but cannot be sold on the market. Considerable interest is being taken in the Hopkinson process for the desiccation of latex, which may become a new and valuable commercial process for the preparation of raw rubber.

Alcohol Investigations.

The most promising raw product for the production of fuel or power alcohol appears to be the Nipah Palm, the fruiting stalk of which, when treated by special methods and subsequently tapped in a manner similar to that employed for tapping the coconut spathe (unopened flowering stalk) for the production of toddy, yields a saccharine juice which can be fermented naturally to alcohol. The yield of alcohol is about 6.5 per cent on the weight of the juice. The area of indigenous palms in this country, especially in any one district, is not large. The cultivation of the palm has been taken up already by two syndicates, although our information on possible yields is still somewhat meagre, due to the fact that most indigenous palms have been cut previously for attap, which almost certainly affects the yield of juice on tapping, and also to the fact that the yield of individual palms, as in the case of other economic plants, probably varies considerably.

Two small areas have been reserved for the Department for the experimental planting of Nipah Palms, in order to obtain information on the growth and maturation period of the crop.

A report on the investigations to date is being compiled and will be ready shortly.

Investigations on the production of alcohol from lallang grass have given unsatisfactory results.

Other starch yielding crops e.g. tapioca. sweet potatoes and Jerusalem artichokes will also be considered in this connection, and also the manufacture of sugar from Nipah Palm.

There is a possibility of the revival of the sugar industry which may also be of value in connection with the manufacture of alcohol from molasses. An investigation on the preservation of toddy has also been made, but the work was not completed at the end of the year.

VEGETABLE OILS AND FATS.

Investigations of the following oil seeds, oils and fats and oil cakes etc., have been made:—

Copra, desiccated coconut, copra or coconut oil, oil from desiccated fresh coconut, palm fruits, palm oil and palm kernel oil, croton oil, illipé fat, nutmeg butter, seeds of *Xylocarpus moluccensis* (Nyireh batu) and *Xylocarpus oborata* (Nyireh bunga) (both jungle fruits) cashew nut and oil, chaulmoogra seeds imported from Burma for planting purposes, candle nuts and candle nut oil, kapok seed and kapok seed oil, seed and oil from seeds of *Sterculia foetida* (from Brunei), rubber seed oil, castor seed cake and oil, *Calophyllum Inophyllum*, *Nephelium lappaceum* (rambutan), *Nephelium mutabile* (pulasan) and Curcas (purging nut) seeds.

Of the above oils only coconut oil and palm oil are at present of any real commercial interest and value, although illipé from various islands - chiefly from Borneo and Sarawak — are imported into Singapore. At present however the fat is only expressed occasionally and all the seeds are re-exported to Europe.

A special pamphlet on the manufacture of desiccated coconut products and other tinned coconut products has been prepared and distributed.

Investigations on these products have also been carried out in the laboratories.

It is of interest to note that the proprietor of a copra oil mill in Penang has commenced the manufacture of shredded desiccated coconut near Butterworth. An investigation of the quality of the copra from coconut trees tapped for toddy compared with copra from untapped trees has been carried out. The results showed no important differences in oil content, so that the problem of tapping for toddy

concerns chiefly the yields of copra. An investigation of copra from nuts of different dwarf varieties of coconuts showed no differences in oil content.

Advice and assistance has been given to one estate in connection with the manufacture of palm oil.

Essential Oils.

Investigations on the essential oils of citronella, lemon grass patchouli, American worm seed (Chenopodium oil), clove, nutmeg, and vetiver roots, have been carried out. Distillation of the raw materials on a semi-commercial scale have also been conducted and samples of the oils sent to London for valuation. At the present time there is probably not much profit, except in the case of the more valuable essential oils, such as patchouli and vetiver oil.

Lime and Lime Products.

Considerable advice and assistance has been rendered to one syndicate in connection with the manufacture of lime products.

It is advised at present that attention be paid to the manufacture of concentrated lime juice and hand-pressed and distilled oil of limes. The problem of the manufacture of citrate of lime and more especially citric acid can be considered later, when more experience has been gained by the estate concerned.

Fibres.

Considerable interest has been taken in the cultivation of various fibres but apart from roselle, very little actual cultivation has so far been carried out.

Samples of jute, roselle, sisal hemp, sansieveria (furcrea) or bowstring hemp, Mauritius hemp, pineapple fibre and several miscellaneous fibres have been examined during the year.

Several bales of roselle fibre have been prepared and sent to various firms and individuals.

An investigation of the buoyancy value of Malaya kapok compared with Java kapok has been carried out and a report prepared for publication. The samples examined, which were not of the highest quality obtainable, conformed to the standards laid down by the Board of Trade for the use of this fibre or floss in life-saving apparatus.

Paper and Paper-pulp.

During the early part of the year a large number of exhibits of pulps cardboards, etc. was prepared from various local raw materials includiug bamboos, wood, lallang grass and citronella grass, for the Malaya-Borneo Exhibition. Later in the year, samples were prepared and sent to England and to the Forest Research Institute,

India for valuation and report. Samples were also handed to another applicant who was proceeding to Denmark with the intention of endeavouring to form a Company or syndicate to operate in Malaya.

Arrangements have been made with the Forest Research Officer F.M.S. to obtain further supplies of raw materials in order to continue these investigations.

Forest Products.

A number of resins (Damars) Oleo-resins, wood oils, and oil seeds have been investigated for the Forestry Department during the year and a programme drawn up in conjunction with the Forest Research Officer to continue these investigations during 1923 and subsequently.

Samples of Jelutong Rubber are under investigation in connection with its use as a chewing gum.

A sample of wood from an Entada species (Akar sintok) has been examined and found to contain a saponin.

Soil Investigations.

Over 100 soils have been examined and reported on during the year and over 100 samples are still awaiting investigation or are in the course of examination.

These include 47 samples examined in connection with a padi irrigation scheme and several samples from the Cameron Highlands.

There is nothing of special interest to report in connection with these samples.

Fertilizers.

A number of samples of local guanos and phosphates have been examined and found to be very variable in composition.

Samples of Canton mud and local Chinese fish pond mud, used to a considerable extent for horticultural purposes, have been examined and a report published in the Malayan Agricultural Journal. Several miscellaneous waste products have been investigated in this connection and found to be of little value.

Miscellaneous Investigations.

Under this heading are included samples of acetic acid, sodium sulphite and sodium bisulphite and ammonia received from Estates or Firms. The poor quality of some of the chemicals examined illustrate the necessity for analysis in controlling the quality of such chemicals.

A sample of worm killer was found to consist of illipé seed meal, which contains a saponin useful for the purpose.

A sample of a Eucalyptus fungicide from Australia and a sample of a chemical recommended for the prevention of "spot" disease on prepared raw rubber have been investigated.

Three samples of barium carbonate used for rat destruction and two samples of lead arsenate used as a spray for the destruction of cockchafers were examined.

Two samples of water were examined.

One sample of tobacco for nicotine content was examined. Samples of tobacco grown on Serdang Estate are also under investigation for nicotine content. The object of these investigations is to cultivate tobacco with a high nicotine content for use as an insecticide.

Publications, Lectures, Etc.

Apart from contributions to the Handbook of Malayan Agriculture, the Agricultural Chemist prepared an article on Malayan Agriculture in connection with the visit of H. R. H. The Prince of Wales and also contributed the section in Agriculture to a book on the Geography of Malaya edited by Dr. Winstedt. Numerous articles on various subjects have been published in the Malayan Agricultural Journal during the year by the staff of the Chemical Division.

A lecture on "New uses for rubber and the preservation of latex for shipment" was delivered by the Agricultural Chemist before the Kajang District Planters' Association and published subsequently in "The Planter."

A feature of work during the year has been the large number of enquiries in connection with products other than rubber and the number of special reports prepared on various subjects, together with a large number of interviews.

Local Industries.

Investigations and enquiries are being made in connection with various local industries and the establishment of new industries.

There are a number of small soap factories in the Federated Malay States and the Colony and it is hoped to be able shortly to assist and advise these in connection with their products. Apart from the desiccated coconut factory mentioned previously a pineapple canning factory has been erected in Klang and there is a probability of starting a rubber works in the Federated Malay States. In connection with the manufacture of coconut oil the writer was informed recently that the oil mills in Singapore at present found it difficult to dispose of oil, although there is no difficulty in exporting copra at a fair price.

The cultivation and distillation of the more valuable essential oil plants such as patchouli and vetiver should prove remunerative.

So far, sugar cultivation has not been revived, although land has been acquired for the purpose. The manufacture of industrial alcohol from the Nipah Palm should prove a useful local industry, if the cultivation of the palm proves an economic success.

It is hoped also that the output of Palm oil and the expression of palm kernel oil and the manufacture of various lime products will prove an economic success.

Considerable interest has been taken in the manufacture of various articles, especially soles for boots and shoes and mats from raw rubber. The Peachey process of vulcanisation has not yet been established in the East, but the Schidrowitz process of vulcanisation is being tested on scientific lines on one estate.

The Laub process of vulcanisation also continues in operation in Johore. Considerable interest is being taken in the export of latex for the manufacture of latex-paper and also for the impregnation of fabrics and cords for tyre manufacture.

It is possible that such materials might be treated locally.

Interest is also being taken in the desiccation of latex as a new method of preparation of the raw product and it is possible that the process may be instituted in the Federated Malay States.

GENERAL.

The Experimental Vulcanising Factory and the Experimental Paper-making Factory, together with decorticating machinery and baling press for fibres have been under the control of the Chemical Division.

ANNUAL REPORT OF THE CHIEF AGRICULTURAL INSPECTOR FOR 1922.

BY F. W. SOUTH.

I.—STAFF.

For the first time for about four years the division has had a complete staff of European officers during the whole year. This has had a beneficial result on the general efficiency of the work and has enabled the division to make a successful start with several new lines of work which it is hoped will lead to results of considerable value.

There were very few changes among European Officers. On January 1st Captain S. D. Timson, M.C. assumed duty as Assistant Agricultural Inspector, Penang, Province Wellesley and the Dindings, thus relieving Mr. F. Birkinshaw, Assistant Agricultural Inspector, Perak North of his additional duties in the Colony.

On August 3rd, Mr. A. G. G. Ellis, Inspector of Agriculture, Johore, proceeded on leave to Europe. Mr. A. E. C. Doscas was seconded from Negri Sembilan to act as Inspector of Agriculture in his place, and Mr. W. N. Barnes, Special Field Officer, Kuala Pilah was appointed to act temporarily as Assistant Agricultural Inspector, Negri Sembilan in place of Mr. Doscas. Mr. Ellis resigned the service in November and the acting appointments were continued until the end of the year. There were no other changes.

Special Field Officers.—By the end of June the services of all three of the Special Field Officers employed on the control of Pink Disease in Ulu Selangor district had been terminated, as the situation there had much improved.

In Negri Sembilan three Special Field Officers were working on the control of Mouldy Rot disease from the beginning of the year until the end of July, when one, Mr. W. N. Barnes, commenced to act as Assistant Agricultural Inspector, Negri Sembilan. The services of the remaining two officers were terminated on November 30th, as it was considered that after that date the work could be done by the normal staff.

Such transfers have been made among Malay Officers as have been necessary for training purposes; qualified officers have received promotion; and three Apprentices unable to qualify for promotion have had their services terminated.

In the Colony and in Johore the whole staff of Malay Officers on the departmental schemes is still in training. This means that at present only a proportion of them are available for field work at any given time, as some are always at headquarters, taking lecture courses and working in the laboratories.

Recruiting of the Malay Staff has been handicapped by the necessity for economy. It is to be hoped that this necessity will not continue long enough seriously to impair the efficiency of the division; more especially now that it is undertaking the important instruction duties described in the following paragraphs. It is clear that the division cannot attain its best results until the staff has been fully established and trained, so that officers can settle down in their respective districts and continue in them for some time without being transferred.

Instruction Duties of the Inspection Staff.

From the first of July an arrangement was approved whereby the inspecting officers add to their duties certain lines of Instruction work necessary to bring to the knowledge of the planter and, in particular, of the Asiatic cultivator the results of the experimental work carried out by the research officers at headquarters. Such lines of work include the running of Experiment Stations for padi and possibly for other crops; the establishment of padi testing stations to test the suitability of pure strains under varying local conditions; the planting of demonstration plots for pure strains of padi and for new crops likely to be suitable for small holders; the distribution of seed, especially padi seed, and the giving of advice to small holders on any subjects of interest to them.

To obtain the best results it will be necessary for all inspecting officers to gain the confidence and interest of those among whom they work. For this reason it is desirable to retain officers for as long as possible in the same areas and to avoid transfers, so that each officer may become personally known to those for whom he is working.

This scheme has only been in operation for six months. It is a purely tentative arrangement at present to avoid the heavy expenditure entailed in providing an entire, new Instruction staff. The beginning, however, promises well. The work of the inspecting officers is certainly rendered far more interesting, while several useful lines of work have been started, and no administrative difficulties likely to interfere with the smooth working of the scheme have, so far, been experienced.

II. Estates Visited.

The total number of estates visited throughout the Federated Malay States, the Colony, and Johore was 326, of which 97 were visited more than once, and 119 by request.

This compares with 160 estates visited in 1921 including 83 visited more than once. A large number of these visits have, as usual, been for the purpose of advising on the control of pests and diseases; but in several instances thay have been connected with the growing of new crops, or of crops other than rubber.

III. Diseases and Pests of Rubber.

1. *Stem Diseases.*

Pink Disease. (*Corticium salmonicoler* B. & Br.). This disease was newly reported from 40 estates in the area covered by this report, making a total of 328 estates from which it has been reported. In all 1734 notices were served requiring the treatment of the disease. Failure to comply with the notices led to 106 prosecutions, of these 100 persons were convicted and fined sums amounting to a total of $1,668/- with $14.75 costs.

The disease was found in three widely separated localities in Penang island for the first time. Two of these are on the western side. The previous freedom of the island from this disease, combined with the fact that the affected holdings are not less than 15 miles from the nearest centre of infection on the main land, suggests that the fungus was introduced through the agency of birds.

In about four instances it has been necessary to insist on the proper treatment of this disease on European owned estates where it had been neglected for reasons of economy. In two or three cases the advice of the department has been sought for improvement of the control measures in use, since they were proving ineffective; mistakes have been pointed out and rectified. The Inspector of Agriculture, Johore, discovered that the disease was often prevalent on Japanese owned estates because the Managers were ignorant of its nature and treatment; he has, therefore, given special attention to advising these estates.

The routine control measures have been regularly enforced everywhere, so that the disease is well in hand is most areas. Early in the year special measures for reducing its prevalence in Ulu Selangor district were in progress under the Special Field Officers and the Junior Agricultural Assistant, Ulu Selangor. These proved effective and the disease is now considerably less prevalent. Demonstrations of the proper treatment were given and had good results. The situation had so much improved that it was possible to dispense with the services of all the Special Field Officers by the end of June. The Junior Agricultural Assistant has since been able to keep the disease well under control by himself. There has been no large spread of the disease. An area near the Sungei Buloh Forest Reserve in Selangor, where there is much young rubber, became infected early in the year and two or three estates have had to establish pest gangs to keep the disease under control. Sporadic attacks appeared in Kinta district and around Kuala Lumpur, where cases are only occasionally found. These received prompt treatment and the fungus did not spread.

A small pamphlet and standard instructions for the treatment of the disease to be attached to Notices served under the Agricultural Pests Enactment were prepared by the Chief Agricultural Inspector and translated into Chinese, Tamil and Malay.

2. Bark Diseases.

Mouldy Rot. (*Sphaeronema fimbriatum* E. & H.). This disease was newly reported from 11 estates in Negri Sembilan, 2 in Selangor, 1 in Perak and 6 in Johore, making a total of 71 estates from which the disease has been reported. In all 3,188 notices requiring its control were served. 299 persons were prosecuted for failure to obey orders and 261 were convicted. The total fines inflicted amounted to $1,083.50 with $171.50 costs.

In Negri Sembilan the work of the Special Field Officers has led to a general recognition of the disease in all infected areas and a general knowledge of the methods of treatment and control. It has, however, been impossible completely to eliminate the disease. This is partly due to the fact that the fungus possesses spores very resistant to drought which enable fresh infections to appear in damp weather, even when the trees have been healthy for some time; and partly because, owing to poverty, small holders cannot be induced to cease tapping their trees, sick and healthy trees being tapped alike. In such circumstances the disease is always present though kept under control by painting with disinfectants.

In was considered towards the end of the year that the work of the Special Field Officers had had its full educative effect and that no other result could be expected from it. Consequently the services of the two then remaining were terminated on November 30th and the control work was left in the hands of the normal inspecting staff.

The disease has on the whole spread slightly in Negri Sembilan having reached the Selangor boundary at Batang Benar and extended into new areas around Kuala Pilah. The actual percentage of trees affected is, however, distinctly less; while regular painting, which is usually carried out, prevents very serious damage to the bark from this fungus.

There has been no extension of the infected area around Mentakap in Pahang.

In Johore there has been no very marked extension of the infected area, but various local difficulties militate against its successful treatment. One of the worst infected areas is the coastal land between Batu Pahat and Muar where the conditions are unsuitable for rubber, owing to the high water table.

At the beginning of the year the only infection in Malacca was on one estate near Gadek where the disease was regularly treated and at times entirely absent. In the second half of the year, however, it appeared at four new centres, namely Sungei Rambai, Sebatu, Batu Gajah and Chin Chin. These are all on the Johore boundary and were almost certainly infected from the Muar district, probably by wandering tappers. The disease in this area is entirely confined to small holdings mostly owned by Chinese who have to be taught the need for treating it and the method of treatment, and then often disregard orders entirely. Consequently control is not easy and numerous prosecutions become necessary.

In October the disease was found in a belt of small holdings at Sepang about 3 square miles in extent. The Assistant Agricultural Inspector, Selangor, gave a demonstration of the treatment which was well carried out with satisfactory results, as only 5 owners failed to treat their trees thoroughly. These were summoned and fined.

During November and December the disease was reported on two estates in Selangor on the Negri Sembilan boundary in Ulu Langat district. It was promptly and effectively treated. No small holdings in this area were attacked.

In both cases the disease had probably spread into Selangor from adjoining infected areas in Negri Sembilan.

Towards the end of December one estate near Padang Rengas in Perak with an adjoining area of 3-4,000 acres of small holdings was found to be infected. Prompt measures were taken to ensure treatment and these promise to be effective.

It is difficult to see how the spread of this disease to all parts of the Peninsula is to be prevented. Infection is easily carried on the knives and clothes of wandering Chinese and Javanese tappers. Reports of outbreaks on small holdings are scarcely ever made by the owners, so that such have to be discovered by the inspecting officers who can only visit any given part of their district periodically, and may thus not find the disease until it has been established for a few weeks.

The department has continued to render available supplies of suitable disinfectants to small holders at cost price.

Black Stripe (*Phytophthora sp.*) This disease was newly reported from 8 estates in Selangor, 1 in Negri Sembilan and 2 in Johore. Making a total of 115 reports in all. There were 51 notices served requiring its treatment and 4 persons in Pahang who failed to comply with the orders were fined a total of $59/- with $2/- costs.

The disease was present on certain previously infected estates in Perak, but received regular treatment. It has also been present on certain estates in Selangor and on a few small holdings chiefly in Ulu Langat and Kuala Selangor districts. The disease is still present in Jelebu district of Negri Sembilan and in parts of Pahang, especially Temerloh and Kuantan districts. Two small outbreaks have been recorded in Johore. On the whole this disease has been of little importance during the year.

Brown Bast. This bark affection is noticeable everywhere on small holdings where affected trees have not been thinned out and heavy tapping still prevails. It is far less common than formerly, on estates, probably owing to the more conservative tapping systems that are now almost universal.

3. *Root Diseases.*

Fomes lignosus. Klotsch. This root disease has been present as usual in fields of young rubber in various parts of the country. In the Director's Annual Report for 1921 attention was called to the fact that a thick cover crop on land not cleared of timber will assist the spread of the disease. Instances of this have been recorded by the Assistant Agricultural Inspector, Perak North. It is certainly advisable to remove all lying timber before planting a cover crop. Experiments were conducted by the Assistant Agricultural Inspector, Perak North, to determine if all infected jungle stumps, standing in a cover crop on a young clearing, could be discovered by periodical examinations to ascertain if the fruits of the fungus were present on them. It was found, however, that such examinations did not reveal all infected stumps, because the fruits develop irregularly and do not last long. The most satisfactory system is undoubtedly to remove all stumps as well as lying timber before planting a cover crop; but if care is exercised and all affected young rubber trees, and jungle stumps seen are promptly treated, it should be possible to prevent serious loss, even if the jungle stumps are not all removed.

In Province Wellesley *Fomes lignosus* has been observed in certain instances to spread from buried coconut stumps and trunks and cause the death of an abnormal number of the surrounding rubber trees. Attention has been called in the past to the danger of burying cocouut stumps and timbers between rows of rubber trees. Vide *Agricultural Bulletin*, Federated Malay States, Vol. VI. p. 269.

The Inspector of Agriculture, Johore, noticed that, owing to lack of knowledge, *Fomes lignosus* is often left untreated on Japanese estates in Johore and is in consequence often found on such estates attacking mature trees. He has spent much time giving field demonstrations and general advice regarding its treatment on these estates and his efforts appear to be appreciated. He intends to give regular demonstrations in pre-arranged areas to Japanese, as they control large areas of Rubber in Johore.

One or two instances have been recorded of damage to fields of old rubber trees by wet rot *Fomes pseudeferreus* Wakef, dry rot *Ustulina zonata*, (Lev. Sacc) and brown root disease all working together in the same area. Such outbreaks have invariably been due to the facts that the decaying timber has been removed from these fields too late and, in some cases, that thinned out rubber trees have not been burnt promptly. In Johore wet rot disease does not appear always to receive the attention it deserves. In one instance it was found on a clearing only two and a half years old.

During the year 39 notices were served requiring the treatment of root diseases. There were no prosecutions.

Other diseases of rubber such as patch canker, die back and *Sphaerestilbe repens* B. and Br. have been observed, but do not require further record.

4. *General Sanitation.*

The policy of requiring the removal of dead rubber stumps and timbers from small holdings has been maintained. In all 521 notices were served with this object. Two persons who did not carry out the instructions in Malacca were prosecuted ; one was convicted and fined $25 and costs 50 cents.

All rubber stumps have been removed from the road sides and Crown lands in Malacca, but similar work still requires to be done in Singapore.

Thirty-one notices were served on account of extremely bad tapping such as would render the trees liable to attack by pests and diseases. There were no prosecutions.

IV. Diseases and Pests of Coconuts.

1. *Diseases.*

A few cases of bud-rot and of leaf spot caused by *Pestalozzia Palmarum*, Cooke, have been recorded but neither disease has been of much importance. One or two new diseases are under investigation. On an estate in Perak North young dwarf palms were observed to die after germinating successfully. The cause of this is under investigation.

2. *Insect Pests.*

Beetles. Black Beetle (*Oryctes rhinoceros* L) and Red Stripe Weevil *Rhyncohphorus Schach*, Oliv). The routine work of destroying dead coconut stumps and timbers, dead stumps and timber of other palms, village refuse and accumulations of cattle manure likely to serve as breeding places for these beetles has been continued steadily throughout the year. Good progress has been made in Penang, Province Wellesley, Bagan Datoh district of Perak, the coastal area of Selangor and in Singapore. Beetles are now far less numerous in these once badly infected areas and the coconut trees often show an improvement in yield as a consequence. In other parts of the country these insects have not been much in evidence. Malacca is now comparatively free from them owing to the work done in the past. In Johore breeding places, of the black beetle especially, are fairly numerous.

In all 4,900 notices were served requiring the destruction of possible breeding grounds for beetles. Owing to failure to comply with these orders 268 persons were prosecuted and 241 were convicted and fined sums amounting to $819.75 with costs $118.89.

In Pahang one man was fined $10 and costs 50 cents for felling coconut trees without permission.

Brachartona catoxantha, Hamp. During the last quarter of the year slight outbreaks of this caterpillar pest were reported in Selangor, one at the 6½ mile on the Kuala Selangor-Sabak Bernam road, the other at Sabak Bernam.

Thosea sp. A small attack by the caterpillars of this insect occurred on about 10-15 acres of coconuts at Sungei Batu in the South-west of Penang island during September. When discovered in October the attack was over. Possibly it was terminated by parasites of the insect. The foliage of the attacked trees was rather badly damaged.

Grass-hoppers. In a few instances grasshoppers, principally *Cyrtacanthacris luteicornis*, Serv., have damaged the leaves of coconuts; on two estates in Selangor, on which giant mimosa (*Mimosa invisa*, Mart) was grown as a cover, grasshoppers, mostly *Orthocanthacris nigricornis*, Burn., damaged the mimosa and then attacked the young coconuts.

Manila Beetles (*Diocalandra frumenti* F.) Specimens of these weevils were found in decaying parts of living coconuts on an estate in Selangor and were believed to be causing damage. These insects are always found feeding on decaying material and it is most improbable that they are ever responsible for any direct damage to coconut trees.

Other pests which have been recorded in different parts of the Peninsula as causing some damage are; the "greater" coconut spike moth (*Lirathaba* sp. near *trichogramma*, Meyr); the "lesser" coconut spike moth (*Batrachedra arenesella* Walk.); Skipper caterpillars, mostly *Hidari irava*, Meyr.; and *Plesispa reichei*, Chap. on young coconuts. Rats and squirrels are so universal as to require no special mention.

V. Pests of Padi.

Generally speaking the 1922-23 padi crop has been remarkably free from pests, very little serious damage has been caused anywhere by pests other than rats.

Nymphula depunctalis, Gn. Owing to the damage done to the 1921-22 crop at Matang Road by this insect and *Parnara mathias*, F., a strict look out was kept early in the 1922 planting season for the first appearance of the former pest. As soon as it appeared on the young plants in the nurseries spraying machines were provided, and the cultivators were instructed to spray all affected nurseries with a solution of tuba root. The pest was found to be prevalent, breeding on grasses which overhung and grew in the water in canals and distributaries. As soon as there was sufficient water to flood the bendangs the pest spread to the grasses growing therein. Control measures, therefore, consisted of clearing all grass from canals and distributaries. In this work the Executive Engineer rendered ready assistance by clearing up the road drains and larger canals. The cultivators cleared the grass from all smaller distributaries. Through the District Officer and the Penghulu pressure was brought to bear to enforce the simultaneous "menajak" of all bendangs with fairly successful results. Up to the end of the year the padi in this locality has suffered much less from pests than it did last year, probably owing to the early inauguration of control measures.

Nymphula depunctalis was also recorded to a small extent in Province Wellesley.

Stem borers. (*Schoenobius incertellus* Wlk., *Diatraea auricilia*, Dudg., etc.). The various species of these insects occurred everywhere in Krian on the 1921-22 crop; they were present in Province Wellesley, and in Krian and Kuala Kangsar districts in Perak on the 1922-23 crop to a less extent. In Selangor advice given by Malay Officers to burn stubble after harvesting has had good results generally as regards controlling these pests.

Other caterpillar pests recorded during the year on padi in Province Wellesley and in Perak North were *Parnara mathias* and *Spedoptera pecten*, Gn.

Leptocorisa sep. These large bugs which suck the young grains of padi soon after the seed has set are known in Province Wellesley by the Malays as "Chenanggong" and elsewhere in the Peninsula as "Pianggang". They did considerable damage to padi near Raub in Pahang at the beginning of the year. Poisoned meat baits were tried as a control, but with uncertain results. They were present, but only to a slight extent, in various localities throughout the Peninsula at the end of the year.

Nephotettix bipunctatus, F. These insects did some damage in two localities to the 1921-22 crop in Perak North, and in one locality in Province Wellesley to the 1922-23 crop.

Podops coarctata, F. "Bena Kura" or Kutu Bruang." These insects were found in padi stubble in Perak South, thus proving that they can exist between crops. They did considerable damage in one area at Bandar.

In Pahang East they were less prevalent in 1922 than is usual. They were found doing some damage at Sri Menanti, Muar in Johore.

Mole crickets. (*Gryllotalpa sp.*) "Sesorok". These did some damage at Bandar in Perak South in an area of young padi that was dry. The insects disappear when the bendang becomes wet. A proper system of water control would appear to be the only satisfactory method of combating both Podops and Mole Crickets.

Rats. This pest has been, as usual, present everywhere and has done a considerable amount of damage. A supply of ½ ton of barium carbonate was obtained from Europe early in the year and distributed to all the Assistant Agricultural Inspectors for sale by them and by District Officers to Malay padi growers at cost price, namely 1 cent. per oz. Careful instructions were given as to the method of preparing poisoned baits. The supply became exhausted before the end of the year and a fresh supply was ordered by cable, but had not arrived at the close of the year.

The poison seems on the whole to have acted efficiently. There was a complaint that part of the supply was not satisfactory from

one district in Selangor, while in Negri Sembilan the Malays consider that barium carbonate is effective against the small rat, but not so effective against the large rat, "Tikus mondok". Reports from Malacca are variable, but success has usually followed when the baits have been properly prepared and used. Heavy rains occasionally render the poison useless by washing away the baits. It is difficult to determine the efficiency of poisoning exactly, as dead rats are not often found, they die in their holes or in water. Malays are liable to doubt its efficiency if no dead rats are found, but on the whole, judging from the demand, the sale of supplies at cost price has been successful.

Traps have given good results at the Experiment Station in Malacca this year and in other localities in the past and should be used to supplement the poison. It may be possible to stock traps and sell them at cost price in the coming year.

Rat control would be assisted if the padi cultivators could be induced to keep the land surrounding bendangs and sawahs free from tall grass and blukar which shelter rats; and also to remove the mounds of earth so frequently seen in padi fields, in which rats can make holes without reaching the water level.

As stated last year, the best results cannot be attained until all these measures are systematically applied by all owners of land in a given sawah or bendang, from the commencement of the planting season until the harvest.

VI. Lalang and Blukar.

Throughout the country a number of small rubber holdings have become covered with lalang and blukar. Owing to the poverty of the owners caused by the low price of rubber, it has not been considered advisable to insist that such holdings be cleaned. Where the lalang has threatened to spread into clean land orders have been given that a strip 1 chain wide be cleared along the boundaries. Where mouldy rot disease occurs it has been necessary to require that the undergrowth, when present, shall be kept cut.

On coconut holdings an attempt has been made to insist on the cutting of bushes and a reasonable degree of cleanliness.

Numerous instances on estates have shown that Giant Mimosa, (*Mimosa invisa*, Mart.) can form a cover capable of smothering all lalang present on young clearings where the soil is suitable. It is, however, as yet uncertain how long the cover crop must be present before the roots of the lalang die. In some instances, after a period of not less than 12 months the mimosa itself has died down, though self sown seedlings have appeared which may renew the cover, this is at present uncertain. If the cover dies in this way, it is quite possible that some of the original lalang, where it has been present, may retain enough vitality after only 12 to 18 months to grow again vigorously and cause trouble. Further observations are necessary on these points.

In the meantime experiments are being started on a few native holdings in Perak North to test the use of giant mimosa for eradicating lalang on such holdings.

In all 3201 notices were served requiring the clearing of holdings from lalang and blukar, of these over 2,000 were served in Johore. For failure to comply with the orders 268 persons were prosecuted, of whom 231 were convicted and fined a total of $689 with $94.10 costs.

VII. WATER HYACINTH (*Eichhornia crassipes*, Solms.)

In Province Wellesley this weed has blocked many drains in the Sungei Acheh district which are being cleared by the Public Works Department at the request of the Assistant Agricultural Inspector.

In Perak North the gang formed two years ago to control this pest in Krian and elsewhere has worked steadily throughout the year. The Perak river was cleared once between Kuala Kangsar and Ayer Mati in the mukim of Bota, the work lasting from mid June to the end of August.

A considerable amount of work has also been done in Perak South. The Perak river has been thoroughly inspected from the Kuala Kangsar boundary and all places noted where this pest is growing; several tributaries were cleared. State land near Kampar was cleared of the weed by the Assistant Agricultural Inspector, Perak South, and mining land in the same neighbourhood by the owners. The Sanitary Board, Teluk Anson, cleaned up patches of the plant near the town. Work will be continued in 1923 with the assistance of the District Officer, Lower Perak, who kindly supplies reports of the presence of the weed through his Penghulus.

In Selangor patches of the weed on State land have been removed and privately owned land has been cleaned by the owners. The Collectors of Land Revenue have co-operated in this work.

In Pahang East a few patches of the plant were removed. None was seen by the Assistant Agricultural Inspector for the last 4 or 5 months of the year.

In Negri Sembilan the number of places where the Water Hyacinth is found has been largely reduced; where found it is usually in very small quantities.

In Johore the control of this pest is in the charge of the land officers, not of the Agricultural Department. The Inspector of of Agriculture reports that it is cultivated by Chinese gardeners and pig-breeders throughout the State. It has also been noted growing in Government waterways.

The total expenditure on the destruction of Water Hyacinth in the Federated Malay States in 1922 was $1,935.78 from a vote of $7,000. This in itself is evidence that the pest is well under control. In Negri Sembilan 12 persons were prosecuted for keeping Water

Hyacinth on their premises, of these 11 were convicted and fined $188 with $8.25 costs.

VIII. Pests and Diseases of Other Crops.

Giant snails. (*Achatina fulica*). This snail was reported for the first time at Butterworth in the compounds of houses by the sea-shore. It was apparently introduced from Kedah about 11 years ago by Chinese duck-farmers, who used it as 'feed' for ducks, into an estate in the north of the Province. From there the snails were apparently carried in some lilies obtained from that estate and planted in a garden at Butterworth. At the time the presence of the pest was first reported to the Assistant Agricultural Inspector (April), there were considerable numbers of the snails to be found in the area affected, about 10-15 acres. The owners of the houses in the area reported that the pest was doing much damage to their flower gardens, but the Assistant Agricultural Inspector has found no damage of any importance to any of the staple crops.

The owners of the compounds were advised to collect and destroy the snails daily, and this, together with the unsuitable conditions obtaining in the "Snail area", has so reduced the numbers of the snails that very few are now to be found.

Dieback of Cloves. It has been observed that quite a number of the clove trees in Penang island show a die back of which the cause is at present uncertain. The growers state that it is usually only the trees of some age which show these symptoms, but the statement needs confirmation. The damage is sometimes associated with the presence of tunnels in the branches made by the larvae of a boring beetle. It has been noted that Nutmeg and cashew nut trees, "Janggus" in Malay, (*Anacardium occidentale*, L.) growing near Cloves are also attacked by a stem borer.

Oil Palm. (*Elaeis guineensis*, Jacq.) This palm is occasionally subject to a bud-rot and to a disease known as "bent leaf" which commences while the young leaves are still folded in the bud. "Bent leaf" is most usually found on palms under 4 years old. The leaves are not entirely destroyed, but expand and harden though remaining curiously curved. The palms usually recover and become normal. Both diseases are under investigation by the Mycologist.

Rats do much damage to the fruits of bearing palms. They are apparently attracted in large numbers by the strong smell of aniseed given off by the flowers. The rats live in the palms and eat the fruit in all stages of its development, prefering it apparently to other food, as they do not eat poisoned baits.

Roselle. (*Hibiscus subdariffa, L. var. altissima*). Numerous diseased specimens of this plant have been sent in for examination during the year. A root disease attributed to *Fusarium sp.*,

nematode attacks on the roots, and a bacterial wilt have been recorded. Aphids have been found to cause curling of the leaves and mealy bugs have done damage. The cotton stainer, or red soldier, (*Dysdercus cingulatus*, F.) is commonly found on the plants, especially on the fruits. This last pest is common on several species of malvaceous plants including Kapok (*Eriodendron anfractuosum*, D.C.) and cotton.

Citrus. Numerous pests are found in limes, oranges and pomelos all over the country. Collections of these have been made and sent to the Entomologist for record of distribution. Caterpillars of *Prays citri*, Mill., which bore into the rind of the pomelo and other citrus fruits, are common and cause considerable damage.

Mango. The larva of a boring beetle (*Rhytidodera simulans*, White) is a common pest of mango trees. It did considerable damage to mango and durian trees in Ipoh. The pest causes the death of the branches, on which the dried brown leaves hang without falling. The attack at Ipoh was checked by cutting off and burning all the diseased branches and giving the trees a dressing of manure to stimulate growth.

Banana. The leaf-curler caterpillar (*Erionota thrax*., L.) one of the skippers, is a common pest of bananas everywhere, attacking the wild plant, or cultivated varieties, alike. Usually even when present in considerable numbers it does not produce much effect on the plants.

Grasshoppers. Various species of these insects have done damage to miscellaneous crops on two estates in Pahang also to covers of Giant mimosa and to the young palms on fields of young coconuts. Their prevalence seems to depend largely on weather conditions.

Loranthus spp. Various kinds of Mistletoe, " Dalu Api ", " Api Api " or " Dalu Gajah " are commonly to be found on fruit trees, rubber and shade trees. This pest is very common in Negri Sembilan and in parts of Selangor. Steps are being taken to ensure its removal when found, as it does serious damage if neglected.

Numerous specimens of minor pests and diseases have been submitted to the Entomologist and Mycologist for identification and record.

Collections of certain living pests of importance were made at the request of the Entomologist and forwarded for his use at the Malaya-Borneo Exhibition.

IX. Notes on General Agriculture.

1. *Rubber.*

The price of rubber went as low as 23½ cents per lb. during the year, but, with the prospect of Restriction in October and the accomplished fact in November, the price rose until it was 50 cents per lb. at the end of the year.

The long period of depression has not been without good results. It has caused a considerable reduction in the cost of producing a pound of rubber, usually without serious ill effects to well conducted estates though in some cases economies have been effected by insufficient attention to drainage, disease treatment and general sanitation. It has led to a general policy of substituting cover crops for clean weeding, or of growing low grasses in strips on steep hillsides liable to wash where cover crops cannot be established. The increased use of soil covers should have a beneficial effect, not only on the rubber trees on the estates, but also on padi lands lying below estates, since such lands have in several instances been rendered less productive by the accumulation of silt washed on to them from surrounding clean clearings. It has caused the planting community to take a marked interest in the possible cultivation of crops other than rubber and coconuts.

It is to be hoped that a rise in the price of rubber will not destroy the interest in new crops, nor lead to an undue increase in the costs of production.

The general systems of tapping now in favour on estates are more conservative than they have ever been, one cut on ½ or ⅓ of the tree tapped every other day is a common system, while daily tapping for periods of varying lengths followed by resting periods are also systems in common use. The value of alternate periods of tapping and resting has not as yet been fully determined.

Low prices caused cessation of tapping on many small holdings and resulted also in their neglect or even abandonment in numerous instances. On others, before restriction was introduced, the trees were excessively tapped to make up for the low price by increased yields. Cessation of tapping has had a useful effect on such diseases as black stripe and mouldy rot.

Much interest is still evinced by planters in the possibility of improving the yields of rubber trees by bud-grafting from selected mother trees. Many planters have been making experimental buddings for the purposes of becoming proficient in the method and of training coolies should they be needed later. A few estates have have established large areas of budded trees. The selection of suitable mother trees has, however, not proceeded far in the Peninsula; results obtained from the publications of Dutch Scientists show that the work is still in an experimental stage, and further investigation is necessary before it is certain that increased yields will result from bud-grafting. It is extremely doubtful if the very high yields at first predicted will ever be realised.

2. *Coconuts.*

At the beginning of the year the price of copra was about $11 per pikul, but it fell gradually and was at just over $9 per pikul, when the year closed. In 1921 the price of copra varied from $10 to $13. In Malacca the price of nuts was 2 cents each in the kampongs and 4 to 5 cents in the market, so that nuts were slightly cheaper than in 1921.

The Commissioner of Trade and Customs has kindly supplied the figures showing the export of copra from the Federated Malay States.

atates.	Quantity in Pikuls.			Value of Dollars.		
	1920.	1921.	1922.	1920.	1921.	1922.
Perak ...	330,329	436,054	698,934	7,369,345	5,416,972	6,624,465
Selangor ...	82,225	163,516	214,266	1,697,393	2,054,315	1,982,730
Negri Sembilan	4,270	1,501	5,970	89,364	21,088	54,617
Pahang ..	3,164	7,269	9,449	60,484	77,326	83,753
Total ...	419,988	608,340	928,619	9,216,586	7,569,701	8,745,565

The steady increase during the last three years of the quantity of copra exported is of interest. It may be expected to continue for some time, as there are still considerable areas of young palms not yet in bearing.

A factory for the preparation of dessicated coconut was opened in the Province and was operating successfully at the close of the year.

A few areas have been planted up with dwarf coconuts, but in general the usual tall variety is preferred. At present more information is required regarding the yields to be obtained from dwarf palms over a period of years.

It would appear that the preparation and marketing of copra by small holders offer scope for co-operative methods, since, at present, most of the copra is prepared by local Chinese dealers, who take at least such middlemen's profits as might well go direct to the growers of the nuts.

3. *Padi.*

In Penang and Province Wellesley the 1921-22 crop was reaped in January to March 1922 and proved to be considerably under the average owing to unfavourable rains at planting and at harvest, that caused a great deal of damage. This loss supplies a good example of the advantages that might be obtained in these localities by a system of irrigation which would give a controlable water supply.

Very favourable conditions have been experienced during the present growing period (1922-23), and there is every prospect of an exceptionally heavy crop. One danger, however, threatens, which is the presence of excess water in the bendangs, where the padi was ripening rapidly at the close of the year. If the padi is " laid " by storms, part of it may sprout in the ear and so be lost. This danger could be avoided by a proper system of water control.

The potential yield of the 1921-22 crop in Perak North could be described as well up to the average, although the actual yield in many localities was considerably reduced by rain during harvest.

Owing to the unseasonable weather at the time, the planting oe the 1922-23 crop in Perak North was delayed in all districts, in some mukims by as much as a full month. At the end of the year the crop looked promising.

In Negri Sembilan the padi crop in many districts was partly spoiled by a shortage of water soon after planting and by floods and heavy rain at harvest time. In Jelebu district, however, where the date of planting was altered, the crop which is expected in February is more promising.

In Pahang East the 1922-23 padi crop promises to be good and well above the average for the East coast.

In Malacca the padi harvest for the season 1921-22 was fair, though damage from rain and rats was reported from some districts.

Judging from the appearance of the 1922-23 crop at the close of the year, it seemed as if more than ordinary loss would be suffered by padi cultivators, at the coming harvest. Continued heavy rains at the outset flooded many sawahs entirely, necessitating replanting once or even twice. Padi planted early made good progress and promised heavy yields, but long periods of heavy rain, combined with the weight of the padi ears, caused much padi to be "laid," so that much grain will probably be lost.

In Johore the cultivation of padi is at present carried on on a very small scale, but it is hoped materially to extend the area under cultivation by giving every assistance to growers to improve the varieties grown and increase the yield, and also by helping in the control of pests and diseases.

About two hundred acres of sawah land at Kampong Lukut in Kota Tinggi district is cultivated by Negri Sembilan Malays who emigrated to Johore about 20 years ago. The crop there gave promise of being good. The average yield was estimated at 450 gantangs per acre.

On the majority of such other sawahs as exist the land received insufficient attention, the growth is uneven and backward and rats and birds are troublesome. On one such at Labis an average yield of 250 gantangs per acre is said to be obtained.

As part of the instruction duties to be undertaken, as stated above, by the inspecting officers, the following lines of work for improving the yields of padi have been carried out in co-operation with the Economic Botanist: —

(i) Experiment Station. An experiment station, for selecting pure lines of good local varieties of padi and for testing the suitability to Malacca of certain pure strains from the Krian Experiment Station at Titi Serong was opened on Crown land in the mukim of Klebang Besar, about 6 miles from Malacca, during July. Unforeseen circumstances over which this department had no control resulted in lack of facilities for regulating the water supply, in consequence of which much of the present year's work has been lost. The work will be continued next year.

(ii) Testing stations have been established at Permatang Toh Golam in Province Wellesley and at Talang bendang just outside Kuala Kangsar, in order to test the suitability of certain pure strains of padi from the Krian Experiment Station to local conditions represented by these stations. If satisfactory results are obtained, these stations will serve also as useful demonstration plots. The padi at both gave excellent promise at the close of the year. The yields of the different strains in the coming harvest will be compared with those from the surrounding bendangs as well as with one another. It is intended to establish more of these testing stations during the coming year.

(iii) Distribution of selected seed. During 1921 a certain quantity of seed of selected pure strains of padi was distributed, especially in Perak. This seed has yielded well in many instances and is appreciated by the Malays. As an example, it is interesting to note that in three mukims of Kuala Kangsar district 7 gantangs of seed were distributed in 1921. In 1922 40 persons in these mukims obtained seed from the cultivators who planted it in 1921 and planted up a total of 163½ gantangs. The Penghulu, Chegor Galah, planted his bendang at Jawang solely with the departmental selected strains in 1922.

The distribution of this seed was continued in Perak in 1922 and supplies were also distributed in Penang, Province Wellesley, Malacca and to a small extent in Pahang East. Records of the cultivators receiving this seed have been kept and the yields from their plots will be compared with those of the mixed strains on surrounding bendangs, in order to determine which of the selected varieties are best suited to local conditions in the different districts.

The Assistant Agricultural Inspector, Perak North, intends to start experiments in the coming year to test the effect of growing leguminous crops between seasons in order to improve the yield of padi on certain bendangs on which the yields have decreased in recent years.

The same officer is starting experiments to ascertain if dredged mining land can be restored to good padi land in the course of 3 or 4 years by growing a succession of suitable leguminous green manures on it. This line of work is of considerable importance. Dredges can now lay out the land dredged, evenly, and with a suitable top layer of slime which, with a proper admixture of humus from decaying vegetable matter, should make a suitable padi soil. If a satisfactory method of restoring fertility can be found, it would be possible to dredge the tin from bendangs and restore the bendang in good condition after a few years, and also to turn land at present purely waste into padi land.

Fertilisers. The Assistant Agricultural Inspector, Penang and Province Wellesley suggests that great advantages would be obtained by the opening of Government fertiliser supply stations in each district of the Settlement, at which the rayat could obtain the best and most suitable fertilisers at cost price. The manures at present

used by Malays and obtained from the local Chinese shops are often bad in quality and very high in price. A sample of one of these was sent to the Agricultural Chemist and his report shows that the price charged by the vendor was approximately five times more than the real manurial value.

At present, however, no definite data are available as to the most suitable fertilisers and preliminary experimental work must be done. This will be commenced in the coming year.

Preliminary work in preparing the Experiment Station in Malacca indicated that tractors might be employed successfully and economically in preparing certain types of padi land for planting, and their use at harvest also seems possible. Further experiments on the use of tractors for padi cultivation are proposed for 1923. If tractors can be used successfully at a reasonable cost, their use would overcome the difficulties that arise when numbers of buffaloes in any district die from rinderpest.

4. *Fruits.*

The fruit season in the middle of the year was good in most parts of the Peninsula except in Pahang West where the crop was below the average. Durians, mangosteens and rambutans were especially plentiful.

Tan Kah Khee has opened a pineapple canning factory in Klang which has been operating for the last 3 months of the year. The fruit is grown in Kuala Langat, Klang and Kuala Selangor districts. The price of fruit at the door of the factory has varied from 5 to 2½ cents each.

In Johore two factories near Johore Bahru have been improved and a third has been opened, while another small factory is operating at Kota Tinggi. The area under pineapples in Johore is steadily increasing. The whole of the cultivation and canning is in the hands of Chinese. The average for fruit is from 3 to 5 cents each. The daily output of the two larger factories near Johore averages 10,000 tins each, the Klang factory produces 20,000 tins of 1½ lb. daily.

A small factory was opened in Province Wellesley in August, but had to close down before the end of the year on account of the fall in the price of tinned pineapples from $10.60 to $5.50 per case.

It is estimated that about 5,000,000 fresh fruit are exported from Johore to Singapore annually.

In general, attention to grading the fruit, as is done in the Klang factory, would result in improved prices.

Notes have been made on the varieties of pineapples, more especially those used for canning, and on the methods used for growing them. It is peculiar that, while pineapples do well on poor, washed soils in southern Johore, they also do well on peat in Selangor.

A collection of the varieties of banana growing in this country was completed for Serdang Government Plantation in the first quarter of the year.

5. *Other Crops.*

Roselle. This crop has been grown successfully on a considerable scale on one estate in Perak. On most other estates where it has been tried, it has only been grown on small areas experimentally or for seed purposes. There is now a definite market for the fibre. Its principal use locally is for the manufacture of rope.

On small holdings its suitability is still uncertain. Four demonstration plots have been established in Perak and two in Selangor on small holdings, but the results so far have been doubtful. One plot in Selangor was doing well at the end of the year. The two plots in Selangor were also planted with kapok, but this plant has not developed well from seed sown at stake. Further work with these two plants on small holdings is contemplated.

Tapioca is still grown on a considerable scale in Johore and to a less extent in Province Wellesley, elsewhere there are few large areas of it.

Interest has also been shown in reviving the cultivation of coffee and in the possibilities of limes, tuba root, tea and cotton as new crops. On one Chinese owned estate, the tung oil or Chinese wood oil plant *Aleurites fordii, Hemsl,* is being tried, and one or two European owned estates have planted up areas of candle-nut, *Aleurites triloba, Forst.*

African Oil Palm. This crop gives promise of proving a commercial success on one estate in Selangor. There are a few young estates that have been planted up in the last two or three years, while further planting will probably be undertaken during the coming year in Perak, Selangor and Pahang.

The production of cloves and nutmegs in Penang island is declining, though the quality of the produce is good. Possibly steps could be taken to revive the cultivation of the crops. The present growers are almost entirely Chinese owners of small areas.

X. General Notes.

1. *Instructional.*

In the first quarter of the year officers of the division were much occupied with work in preparation for and at the Malay-Borneo Exhibition.

In November a Conference of Malay Officers of the Department was held in Kuala Lumpur. There were several interesting papers on Co-operation and a visit was paid to the Experimental Plantation at Serdang.

The usual lecture courses for Malay officers in training were continued during the year and departmental examinations were also held to qualify more senior officers for promotion.

The reports of the work of the Inspection Staff for the first three quarters of 1922 have appeared in the *Malayan Agricultural Journal* Vol. X. Nos. 4, p. 106; 7, p. 195; and 10, 11, 12, p. 264.

A summary of the Regulations Controlling the Importation of Plants into the Straits Settlements, the Federated Malay States and Johore was prepared by the Chief Agricultural Inspector and published in the Malayan Agricultural Journal Vol. X. p. 228.

Other branches of instructional work have already been mentioned under different headings.

2. *Legislation.*

The abolition of the appointment of Director of Agriculture and the substitution of that of Secretary for Agriculture in February 1922 necessitated amendments of the Agricultural Pests Enactment No. 13 of 1913 in the Federated Malay States and of Ordinance No. 166 (Agricultural Pests) in the Colony.

At the same time it was considered desirable to abolish the special procedure laid down for the black beetle and red stripe weevil of coconuts and to bring them under the general sections of the Enactment and Ordinance. In the Colony this was all done in Ordinance No. 166 (Agricultural Pests) Amendment Ordinance, 1922, published as Notification No. 1093 in the Straits Settlements Government Gazette of June, 30th, 1922.

In the Federated Malay States the first correction was made in the Agricultural Pests Enactment, 1913 Amendment Enactment No. 9 of 1922, published as Notification No. 4085 in the Federated Malay States Government Gazette of July 14, 1222. The second alteration was made in The Agricultural Pests Enactment, 1913. Amendment (No. 2), No. 27 of 1922, published in the Federated Malay States Government Gazette, Notification No. 7871, of December 20th 1922.

A rule regarding the importation of cotton plants into the Colony of the Straits Settlements was published as Notification No. 1777 in the Government Gazette of October 27, 1922. A similar rule in the Federated Malay States is awaiting consideration of a complete revision of the rules regarding the importation of plants into the Peninsula from countries outside it.

The Destructive Insects and Pests Order of 1922 in England and Wales, revoking the Order of 1921, came into force on July 1st, 1922,

and a similar order in Scotland came into force on August 1st, 1922. The procedure now necessary when plants are exported to England and Wales or to Scotland is given in Notification No. 2015 in the Straits Settlements Government Gazette of December 1st, 1922. The procedure necessary under the 1921 Order was published in the Federated Malay States Government Gazette, as Notification No. 2060 of March 24, 1922. The necessary revision of this Notification was expected to appear early in January 1923.

ANNUAL REPORT OF THE ECONOMIC BOTANIST FOR 1922.

BY H. W. JACK.

Staff.—H. W. Jack, Economic Botanist, W. N. Sands, Assistant Economic Botanist.

Padi.—Experimental work with rice continued to be the main research carried on by this Division and the first five months of the year involved frequent and prolonged visits to the Titi Serong Experiment Station in Krian. The first three months were occupied with the checking, in the field, of the agricultural and botanical characters of all the strains of padi under trial and in preparations for the harvesting which did not begin until the last week of March and finished at the end of May. The Krian crop of 13,906,130 gantangs was less than the average of the last twelve years by 83,000 gantangs. The crop had a "bumper" appearance until some 2 or 3 weeks prior to harvest when showery weather caused a considerable amount of lodging and germination of grain. The prolonged drought which necessitated a postponement of cultural operations at the beginning of the season, was the source of the trouble, for in the period February-March which as usual proved to be the dry period suitable for harvesting, the padi was very immature and the rainy weather began on 18th March and continued right up to the end of May, thus damaging the harvest materially. Had it been possible to perform cultural operations up to scheduled time the crop at harvest would have been higher by at least one million gantangs.

The Bukit Merah reservoir requires to be cleared of the heavy growth of weeds etc. which is rapidly diminishing its water capacity, with the result that a long spell of dry weather, which is of frequent occurrence between May and August, usually means a delay in beginning cultivation. This delay has the effect of postponing harvest so that it misses the dry month of February for which it is timed and the crop suffers in consequence when the short rainy season, beginning at the end of March, damages the crop and renders harvesting operations more difficult and more expensive. Though the crop in 1922 was little below the average, from the experimental aspect, the harvest was a bad one because the rains damaged the different pure strains under trial to a different degree according to the actual weather prevailing during the cutting and drying of each pure strain.

During last season (1921-22) 120 pure strains representing six varieties, and being the best selections from an original collection of 1,300 strains, were tested at Titi Serong Experiment Station for yielding ability. The mean yield of 120 pure strains was over 20% higher than the mean yield derived from unselected seed.

For the present season's tests the number of pure strains has been reduced, by elimination of the least promising, to 67 strains

which were planted up during the last quarter. In addition to these 67 strains, 10 pure strains, previously grown for four years amongst the variety tests were selected for trial of yielding ability this season, as strains of probable utility in certain districts of Malaya. Each of the above 77 pure strains has been planted out in plots of eighty plants, duplicated four times and suitably chessboarded. This planting arrangement has been proved to give averages of sufficient experimental accuracy for the purpose of selection for production of grain.

The best 26 of these strains have also been multiplied in half-acre plots, in anticipation of their distribution for seed purposes, and for testing in other districts should they prove equal to expectations. After the harvest of 1921, small lots (2-3 gantangs) f seed of some of these 26 pure strains were sent to reliable planters in several districts for tests under local conditions and though little could be done towards following up the results of this preliminary distribution in the 1922 harvest, it is most gratifying to find that in most cases these small seed lots are reported to have produced better crops than those derived from unselected local seed.

In several areas it has been found that the entire crop derived from these small seed lots has been saved for seed and distributed amongst neighbouring cultivators without any encouragement from officers of the Department and even without their knowledge. For example, a cultivator in bendang Ulu Papan in the Kuala Kangsar district planted up one-fifth of an acre with Departmentally selected seed and the entire crop of 78 gantangs was distributed amongst 17 neighbouring cultivators, whose lands, fully planted, were recently inspected by the writer.

This natural distribution of selected seed speaks for itself. Through the Inspection Division it is hoped that a large number of small tests of selected seed will be carried out in 1923, the idea being that if the sample lots of seed prove better than local seed, natural distribution of selected seed will take place. These small tests are chiefly confined to the larger padi areas this season, including Malacca, Perak, Province Wellesley and Kedah, but it is intended to extend them to other padi districts in 1923. Reports on the growing crops in the districts mentioned are hopeful, especially in Perak and Malacca though in the latter territory much damage has been done by severe flooding.

Experiments with small power rice mills were carried out with a view to recommending mills for estate rice milling in order to encourage local production and to diminish the beri-beri menace

Rubber.—Little attention is given to this crop because of shortage of staff, but monthly records of individual tree yields have been kept on 800 mature trees for the purposes of investigation into the variation in yield, periodic yields, morphological correlations with yield and of finding high yielding parent trees for ultimate seed selection; for experimental vegetative propagation by different methods and for the study of the genetics of Hevea.

Coconuts.—Monthly records of individual tree yields of fruit have been maintained on 450 trees in connection with a study of individual tree variation in yield, the establishment of some relationship between type of tree and yielding ability, the examination of periodicity of yield, the search for good parent trees for further genetical research and the comparison of their yielding abilities for future use as seed producers. In this latter connection approximately seventy lots of seedlings, each lot being the progeny of a single tree, have been planted at Sapintas. A study is also being made of the botanical and agricultural characters of various types indigenous and introduced, and of the methods of pollination and phases of flowering of the main types.

Cinchona.—The Assistant Economic Botanist (Mr. W. N. Sands) spent three weeks in Java early in the year, investigating the methods of cultivation and manufacture of quinine employed by the Dutch with a view to decide the possibility of establishing this useful industry in Malaya. He also visited all the accessible hills in the Peninsula to report on their suitability for the cultivation of "cinchona." Cameron's Highlands, on which Mr. Sands spent 3 weeks, were found to be admirably suited to the needs of "cinchona," none of the other hills being of sufficient elevation or affording suitably undulating land on a large enough scale

Cotton.—Fourteen types of cotton were grown under pure line conditions on a small scale and several types were found to produce a crop equal to the average obtainable in the West Indies. This crop can be grown on the lighter soils of Malaya, its success depending on good cultivation, close expert supervision and systematised pest control. Moderate rains are essential for the germination of the seed and dry weather is advantageous when the crop is being harvested.

Drugs.—The study of native medicinal plants was initiated during the year, partly at the instigation of the medical authorities, and a collection of fifty-seven different plants was established locally on a small scale. Several of these medicinal plants give promise of possible economic utility and samples have been delivered to the Agricultural Chemist for analysis and report.

Botanical.—Over 120 indigenous plants, economic and ornamental, were identified for members of the Department and outside enquirers during the year. A preliminary investigation of characters of the so-called varieties of the nipah palm was started.

A study of the aquatic flora of the rice fields was initiated partly in connection with rice work and the reclamation of rice land but also partly at the request of the Medical Entomologist.

Sugar-cane.—Twelve types of sugar-cane were selected and handed to the Agriculturist. They now cover some 40 acres at Serdang and some types have given high yields.

Malaya-Borneo Exhibition.—This Division was responsible for exhibits of (*a*) padi and rice and instruments used in padi cultivation,

(*b*) collection of types of coconuts, (*c*) collection of types of sugar-cane, and (*d*) collection of types of nipah palm. The officers of the Division acted as judges of the padi and rice at the Agricultural Show.

Publications.—The following articles were published by the Division during the year :—

(1) Rice Milling for Estates.

(2) Notes on Dwarf Coconuts.

(3) Selection in "Hevea."

(4) Selection in Coconuts.

(5) Report on Java Quinine Industry.

(6) Improvement of Cereals.

(7) Notes on the Brazil Nut in Malaya.

(8) Bud Selection in "Hevea."

(9) Agricultural Possibilities of Cameron's Highlands.

(10) Long Staple Cotton Experiments in Malaya.

(11) Memorandum on Chicle Gum.

ANNUAL REPORT OF THE MYCOLOGIST FOR 1922.

BY A. SHARPLES.

Staff.—Mr. A. Sharples, Mycologist. Mr. A. Thompson and Mr. F. R. Mason, Assistant Mycologists reported for duty, the former on 21st December 1921, and the latter on 6th March 1922. With this assistance I have been able to devote some considerable time to minor crops which was impossible previously.

General.—A feature of the year's work has been the number of queries relating to diseases on crops other than Rubber and Coconuts. Diseased specimens of Roselle, Bananas, *Hibiscus rosa-sinensis*, Tuba, etc., etc., cover crops such as *Mimosa invisa*, *Tephresia candida*, have all been dealt with. Some time has been spent on diseases of Arghan Fibre.

The long-standing investigations on Rubber, Coconuts, and Oil Palms have been carried forward. The following details will indicate the progress made.

Rubber Root diseases.—The importance of root diseases in the future of Malayan plantations was emphasised many years ago by the Department and as time goes on it becomes more evident that many old properties will lose considerable acreages owing to neglect of this question. The prevalence of Root diseases in Malaya touches closely upon future progress when development along lines designed to give increased yields are in vogue. Considerable effort has always been devoted to obtaining more definite evidence on these difficult questions. During the last three years the problem of Brown Root disease has been under consideration.

Brown Root disease.—Up to 1917 the cause of this disease, known as attacking most tropical cultivations, was considered to be *Hymenochatae noxia* (Berk). In 1917 Petch found numerous fructifications of *Fomes Lamaoensis* (Murr) in association with roots of Tea and Rubber attacked by Brown Root disease. He now considers this fungus to be the cause of Brown Root disease.

Brown Root disease on Malayan and Ceylon Rubber and on Camphor.—During 1920 a bad attack of Brown Root disease in a Malayan Estate was encountered. Cultures were obtained from these diseased roots. Specimens of Brown Root disease on Rubber from Ceylon were sent for and successful cultures set up from these specimens. The fungi, in culture, were totally different in appearance. To try to find an explanation for this discrepancy, roots of camphor suffering from Brown Root disease were obtained and cultures made from them. These cultures were again different from the other two. Whilst differing entirely in cultural characteristics, their growth peculiarities on the rubber wood blocks in the culture flasks were

exactly similar. The main point in the investigation is that substantial evidence has been obtained to support the view that different fungi are responsible for the symptoms characterising Brown Root disease on different crops. This work makes it necessary to regard Brown Root disease from a very different angle. A preliminary article on this work was written up for the Malayan Agricultural Journal.

Thinning-out of Rubber in relation to root diseases etc.—Considerable attention has been devoted to this matter in view of the tendency towards the possibility of maintaining yield figures with fewer trees per acre by increasing individual yields and so reducing costs of production. Up-to-date, the experiments are very satisfactory and the response of mature trees, in Malaya, towards better spacing conditions is reflected in the maintenance of yields per acre. An editorial giving details of observations on an inland estate was written up for the Malayan Agricultural Journal. Figures from other experimental blocks on a coast land estate are obtained monthly and provide interesting results. This line of work should provide very definite evidence for future guidance as to estate policy.

Brown Bast.—This interesting disease has been under constant experimental observation since early 1920. Many interesting facts have come to light and many unrecorded features have been demonstrated. The more important points as now established may be mentioned :- -

(*a*) No evidence of organic cause has been obtained.

(*b*) Positive evidence has been obtained to show that increasing the time between each tapping period, materially reduces the number of Brown Bast cases, i,e Alternate Daily tapping on the same length of cut shows a far lower number of Brown Bast cases than Daily Tapping.

(*c*) The relation between yields, tapping Daily, Alternate Daily, and Every Third Day, obvious on $\frac{1}{4}$ and $\frac{1}{2}$ cuts, breaks down when longer cuts are used.

(*d*) That in certain months of the year Brown Bast development is practically nil and that the inception of Brown Bast appears to depend on "Trigger action ,'; there is a sudden burst during certain months. This feature has been marked over the last three years on more than 20 plots.

(*e*) In one plot of fifty trees immune for 11 months very definite evidence has been provided that the sudden appearance of Brown Bast was directly correlated with a sudden increase in yield.

(*f*) That Brown Bast extension on individual trees can be prevented by a deep cut to the wood or by a sufficiently wide bridge of renewing bark. This latter is important because of the weight Keuchenius attaches to his observations on isolations by deep cuts which form the basis of his theory.

(*g*) That Brown Bast in its downward extention is in the great majority of cases greatly impeded, or even stopped at the line marking two panels of different ages of bark.

(*h*) That bad yielders are often attacked to the same extent as good yielders.

(*i*) That Brown Bast is an exhaustion phenomenon: accepting this as a basis, laboratory and field observations previously contradictory, can be brought into line.

These points when elaborated and supported by the figures obtained will be seen to have great significance with regard to future development of Malayan Plantations.

Mouldy Rot.—An effective control for Mouldy Rot on European Estates has been demonstrated over the last two years at a cost of $1.26 per acre per annum. The demonstration provided ample proof that *Agrisol* is a reliable fungicide in the control of Mouldy Rot and the results provide substantial evidence for the view that this disease can be controlled at a low cost and so need not be considered as a factor permanently influencing the policy of affected plantations. Owing to the peculiar spore development there is little chance of eradicating this disease, and its appearance in different parts of Malaya may be expected. It is spreading gradually all round the badly infected districts and a sudden appearance in Perak has been confirmed. Unless neglected, there is no cause for alarm.

Two articles dealing with the *Agrisol* experiments were published in the Agricultural Bulletin F.M.S.

The above deals with the main lines on Rubber, but other interesting matters which might be mentioned shortly are:—

(*a*) *Slugs.* A bad attack of defoliation owing to slugs.

(*b*) *Top-Canker.*—The appearance of Top-Canker supposed to be due to a Phytopthora species. We were not able to confirm this.

(*c*) *Leaf-Fall.*—A case of leaf-fall much resembling that described from India as caused by *Phytopthora meadii.*

Some considerable time was spent on this, but no Phycomycetous hyphae could be demonstrated and no cultures of *Phytopthora* were obtained.

(*d*) *Helminthosporium* (*Nov. sp.*)—A new species of Helminthosporium was obtained capable of growing on young rubber plants causing slight damage.

Phytopthora diseases.—The investigation of the fungi of this genus is of great future importance. At present, much confusion surrounds the various species of *Phytopthora* considered as dangerous to Rubber, Coconuts and Oil Palms. "Black Stripe", "Top-Canker".

Leaf-fall and Pod-Rot of Rubber, Bud-Rot of Coconut and Oil Palms, Nut-fall of Coconuts all come up for consideration in this investigation. Owing to pressure of present work, little progress can be made on these lines.

Coconut and Oil Palms.

Bud-Rot.—In my annual report for 1921 I referred to experimental inoculation work carried out at Castleton Estate, Teluk Anson. The publication of the work as a special bulletin has been held up owing to lack of funds, but the conclusions arrived at have been applied to Oil Palms suffering from Bud-Rot. The soundness of the conclusion has been amply verified and there are numerous cases of Oil Palms suffering from Bud Rot being successfully treated and growing into healthy palms again. In the case of tall growing Coconut Palms there is little chance of successful treatment.

During the year many visits to investigate palms *in situ* suffering from "Bud-Rot" have been made. In several cases the clear connection with insect attacks have been demonstrated. Evidence is being steadily collected to show that, in Malaya, Bud-Rot is a secondary symptom, following on insect attacks and is not to be confused with epidemic Bud-Rot caused by a species of the genus *Phytopthora*.

Stem-Bleeding disease.—This disease has been investigated in Ceylon and at one time was expected to cause much damage in that country. The causal fungus was named as *Thiealaviopsis ethaceticus* (Went). During the last 18 months several estates have been visited showing bleeding of the Coconut Palm stems. The bleeding has been associated with a salmon-pink discoloration of the trunk, white ants, and the presence of *Thiealaviopsis ethaceticus*. Careful comparative observations have led to the conclusion that the salmon-pink discoloration is the important symptom and that the above mentioned fungus and White Ants are secondary symptoms. Inoculations with pure cultures of the fungus *Thiealaviopsis ethaceticus* were unsuccessful. I suspect that the disease is to be traced to infection through the roots and then very slowly progresses up through the tissues of the trunk. As the disease takes a long time to develop there is no urgency in the investigation and this is deferred to more convenient times.

Black Spot disease on petioles and leaf stalks.—A recent investigation of a mature palm which appeared from a casual observation to be suffering severely from a bad attack of *Pestalozzia palmarum* on petioles and leaf stalks showed that this fungus was not prominent on or in the neighbourhood of the spots. The presence of an organism related to *Spongospora* species was demonstrated in the affected tissues. These lowly organisms are difficult to investigate but I hope to spend some time at Kew dealing with this particular organism when I take my leave next July.

Nut-Fall of Coconuts. (*a*) *Mature nuts.*—Falling of mature nuts have been under observation. There appear to be many varying symptoms and up-to-date I cannot report much progress. Petch says a *Phytopthora* sp. is the probable cause in Ceylon but I have not been able to confirm this.

(*b*) *Immature nuts.*—Work on this problem has been undertaken in conjunction with the Government Entomologist.

Collapse of Central Leaves in young Oil Palms.—A well marked feature on young Oil Palms *i.e.*, up to 2 years old, is a kind of incipient "Bud-Rot." The disease commences with the collapse of the 3rd or 4th leaf from the centre. Later the outer leaves collapse but the central leaf remains stiff and healthy. The central leaves continue healthy and finally a set of new healthy leaves is produced surrounded by the collapsed outer leaves. This peculiarity is quite common and is easily followed but the explanation is more difficult. No organic cause has as yet been demonstrated but the suggested explanation is a form of incipient "Bud-Rot" in which, owing to the rapid growth of the central leaves of the "Oil palm," the diseased area is carried away from the central portions.

Leaf Spot on Oil Palms.—Some time has been spent in investigating the fungi causing spotting of the leaves of Oil Palms.

Other Crops. Roselle Fibre. Eel-Worms on Roselle Fibre.—As mentioned above, considerable interest has been show in subsidiary crops. Roselle fibre, the product of *Hibiscus Sabdariffa* var *altissimma* has attracted considerable public attention. From the point of view of diseases this crop varies considerably in so far that a good growth may be obtained as a first crop but the subsequent crops may be rather discouraging. The chief cause of trouble seems to be Eel-worms which kill large patches. A Bacterial disease of the vascular bundles has been noted and also diseased roots showing Phycomycetous hypae. These will receive future consideration.

Argan Fibre.—A visit was made early in the year to the Arghan Fibre Company's Nursery at Rompin to advise on a disease, presumably Bacterial, which was spreading and causing some uneasiness. The matter was taken in hand and the disease successfully put under control. Recently a new collar disease has appeared, probably owing to the extremely wet condition of the soil of the Nursery. The prominent fungus is *Thielaviopsis ethaceticus*, which is common on pineapples, a relative of the Arghan plant.

Tobacco.—Dr. Samuels, Medical Superintendent at Tanjong Rambutan, who is keenly interested in subsidiary crops has sent in specimens of diseased Tobacco and Banana plants. We were able to show how the tobacco disease could be tackled successfully, healthy leaves and seeds being obtained from the diseased specimens sent in.

Final.—Many other crops have come up for consideration, and general enquiries answered. Wither-tip of limes, diseased plants of Tuba Root, fungi on Cover crops such as Centrosema, Tephrosia, etc., *Graphiola phoenicis* on Date Palms, fasciations on Rubber, diseased Cacao Pods, diseased plants of Sisal Hemp have all been under observation.

We have been in communication with several prominent Mycologists and cultures of 10 different strains of *Diplodia* sp. were prepared by Mr. Thompson and sent to Dr. Butler of the Imperial Bureau of Mycology, for transfer to Dr. Shears in America. Cultures of *Phytopthora faberi*, *Phytopthora palmarum* and the *Phytopthora* species causing Black Stripe disease of Rubber were despatched to Prof. O. A. Reinking, for investigation in the University of Wisconsim.

The preparation of specimens for the Malaya-Borneo exhibition took up a good part of the time during the first quarter.

At the request of the Rajah of Sarawak I spent from the 13th of September to October 9th in dealing with a serious outbreak of disease on Pepper Vines in Sarawak. During my visit I was able to spot the cause of the trouble and reported that I considered the disease a preventible one.

During the year the Seychelles Islands administration also asked for aid and advice regarding a disease of Coconuts which appeared to be spreading rapidly.

ANNUAL REPORT OF THE GOVERNMENT ENTOMOLOGIST FOR 1922.

BY

G. H. CORBETT.

1. *Staff.*—The Government Entomologist was in charge of the section throughout the year.

Mr. W. Malcolm Miller commenced duties as Acting Assistant Entomologist on the 1st January, 1922.

Mr. B. A. R. Gater reported for duty on the 18th, December.

2. *Publications.* No special bulletins have been published but manuscripts are ready for publication concerning the life history, habits and control of :—

(i) *Rhynchophorus schach*, Oliv. "Red Stripe" Weevil of Coconut.

(ii) *Plesispa reichei*, Chap. The two-coloured coconut leaf beetle.

(iii) *Podops coarctata*, Fab. "Kutu bruang"—a sucking bug of padi.

The following entomological articles have appeared in the Malayan Agricultural Journal :-

(i) Entomological Jottings, February.

(ii) The Rubber Flower Geometrid (*Hemithea costipunctata*, Moore) April.

(iii) Preliminary Note on the "Lesser" Coconut Spike Moth, May.

(iv) Moths from Coconut Spikes, July.

An article on "*Insect Pests*" appeared in the Malayan Agricultural Handbook for the Malaya-Borneo Exhibition

3. *Investigations.*—During the past year sp[illegible] has been paid to Pests of Coconuts and Padi, and conside[illegible] [illegible]mation has been obtained concerning their life histories and [illegible]. Insect enemies of other plants have been observed and infor[illegible]on with regard to their habits has been recorded for future reference.

INSECTS OF COCONUTS.

Oryctes rhinoceros, Linn. The Black or Rhinoceros Beetle.

The investigation of this insect has been in progress during the whole of this year and will be completed shortly.

The minimum time from the hatching of the egg to the emergence of the adult from the cocoon found up to the present is 119 days.

Experiments under natural conditions will have to be undertaken before this figure can be definitely stated to be the minimum for the life cycle.

Rhynchophorus schach, Oliv. "Red Stripe" Weevil.

A manuscript concerning *Rhynchophorus schach*, Oliv. has been prepared for publication. A brief summary of the results obtained during the investigation of this insect is given below.

1. The palm weevil attacking coconuts in Malaya is the "Red Stripe" Weevil, *Rhynchophorus schach*, Oliv.

2. More damage to individual coconut palms is done by this weevil than by the Black or Rhinoceros beetle (*Oryctes rhinoceros*) or any other insect. The grubs or larvae tunnel in the tissues of the plant, and one such may cause its death by eating into the growing point.

3. Most palms are attacked as well as the coconut, and hence provide alternative food plants.

4. A coconut palm attacked in the crown is detected by the central shoots falling down and in trunk infections by gummy exudations and discarded fibre projecting from the holes.

5. Eggs are not laid in undamaged tissue, but advantage is taken of damage caused by the borings of Black or Rhinoceros beetles, and probably other borers, by "White Ants,' (*Coptotermes gestroi*), and by man.

6. Larvae may be found in any part of a palm. After eight years of age the damage is generally confined to the upper portions of the palm. In palms of fifteen years of age and over, larvae are rarely found elsewhere than at the bases of the leaf petioles, the crown, and about one metre below the last whorl of leaves.

7. Female weevils are capable of laying up to 832 eggs, and once laying [illegible]mmenced it is continuous. The eggs are laid in cavities drill[illegible] the damaged tissue by the rostrum of the female. The holes are[illegible]en closed by pinkish plugs of definite structure.

8. The maximum observed life of a female weevil was 116 days that of a male 107 days.

9. The egg hatches in three days and the resulting larva feeds for a minimum of 59 days. It feeds on the softer tissues only, the fibres being pushed to one side and then forced to the rear of the gallery. A cocoon of fibres is formed when the larva is full grown, and the insect remains in this for not less than 25 days. There are inactive larval and adult stages before and after pupation in the cocoon, during the latter of which the weevil becomes sexually mature.

The minimum time taken to complete the life history, egg to adult, was 87 days.

Eggs may be laid by the female on the day after emergence from the cocoon.

The larvae moult 16-20 times during their life.

10. It was found that grubs can live and complete their life cycle and that adults can emerge from logs buried more than 3 feet under the ground. Eggs were not laid in wood covered by one inch of sand.

11. Preventive measures consist in destroying all possible breeding places of *Oryctes rhinoceros*, and generally preventing the trees from being damaged. All borings caused by the Rhinoceros beetle should receive immediate attention.

Leaf petioles and other parts of the palms should not be pulled off or broken, and all wounds should be tarred at least twice. Toddy steps should not be cut more than one inch deep, and not at all near the crown. Experiments have shown that the newly emerged grubs are incapable of eating through the hard layer of vascular bundles but can eat their way down the leaf petiole into the trunk. Remedial measures consist in burning all palms suffering from crown infection, and all palm refuse. This should be done within three months if no grubs are seen, whilst if they are present it should be done as soon as possible.

12. Trapping with split logs of various palms is not recommended unless large numbers of weevils are present.

Burying logs is inadvisable, because they will form breeding places if any eggs or grubs are in them at the time of burial. Buried logs may be exposed by wash and may form sources of infection.

Plesispa reichei, Chap. [*Hispinae*].

A manuscript on the two-coloured coconut leaf beetle, *Plesispa reichei*, Chap., has been forwarded for publication.

A summary of the work is given below :—

1. This insect is essentially a pest of seedlings in the nursery and young coconut palms in the field up to two or three years of age.

2. It has been found on older trees, but these trees appear to be growing in unsuitable conditions or suffering from previous injury.

3. The eggs which are brown in colour are laid on the leaves.

4. The grubs and adults feed on the surface of the partially folded up leaves.

5. When full grown the grubs pupate on the leaves.

6. The beetles are about ¼ inch in length without the antennae, the wing covers are black, and the head and thorax are yellowish brown in colour.

7. The larva and pupa are yellowish in colour about ¼ inch in length, have lateral projections, and their anal segments terminate in two caliper-like hooks.

8. The eggs hatch in about 7-10 days, generally in about 7 days; the larval stage lasts 30-38 days, usually about 33 days; the pupal stage lasts from 6-11 days, generally about 7 days.

9. Both male and female beetles may live a long time. The maximum length of time found for the life of the male is 9 months and the female about 9½ months.

10. The largest number of eggs found deposited by a female was 112 in 249 days.

11. Nurseries should not be made under coconut trees but should be prepared under other trees or in a shady place.

12. Eggs, grubs, pupae, and adults should be collected from the seedlings in the nurseries. If the stages of this insect are not collected by hand, the central portions of the plant should be well sprayed with Lead Arsenate.

13. Previous to supplying or planting young seedlings should be immersed in a solution of Lead Arsenate at the rate of 4 lbs. to 100 gallons of water. If they have been subjected to heavy rains prior to planting out, and it is considered necessary, they should be immersed again, and after planting out sprayed to kill the larvae which have in the meantime hatched from the eggs.

Batrachedra arenosella. Gosmopterygidae. Walk. "Lesser" Coconut Spike Moth.

During the year 1922, *Batrachedra arenosella*—an unrecorded insect on coconuts—was found in Malaya.

This insect, which causes injury to both male and female flowers of the coconut spike before the spathe opens, was first observed in Perak and later in Malacca, Selangor, and Negri Sembilan. It is probably distributed throughout the Peninsula.

Batrachedra arenosella would appear to be the principal insect injurious to the coconut spike and probably the most serious in reducing the yield of coconuts over large areas.

Unopened spikes forwarded for examination have shown 68 per cent of the female flowers damaged by the caterpillars of this moth.

Unopened spikes, cut from several palms bearing no nuts and from palms considered to be bearing well, have on opening revealed the presence of the caterpillars of *Batrachedra arenosella.* From

both classes of palms the yield might have been greater if caterpillars had not been present.

Frequently when the spathes are cut open injury is not observed, but by taking the inflorescence out of the spathe damage confined essentially to the inner surfaces of the flowers is noticed.

The damage is chiefly seen on the flowers at the basal half of the spike but the marks showing where the caterpillars have entered through the spathe are generally found at the apical half.

The present observations have shown that the eggs of this insect are laid on the outside of the spathe generally between the grooves where the tissue is softer than at the surface.

The egg is very small and when about to hatch the caterpillar may be seen doubled up inside it. The eggs hatch in from two to three days and the caterpillars, having bored through the spathe, feed upon the male and female flowers. The larval stage lasts from 5-8 days. When full grown the caterpillars pupate in white elongated silken cocoons generally at the base of the main flower stalks. The pupal stage lasts from 6-8 days.

In field observations on coconut palms carrying three unopened spikes, the youngest spike has not been noticed to be attacked, the middle spike generally shows slight feeding marks and spots on the inside of the spathe, whilst the oldest spike generally contains caterpillars, cocoons, and occasionally moths. Cocoons with their pupae are, however, mostly in evidence.

The spikes of palms of six years and upwards have shown the presence of caterpillars. Spikes of palms below that age although adjoining areas where this insect was present were not observed to be attacked.

Control.—Experiments are being conducted in order to find out a satisfactory control for this insect. They consist in spraying the spikes with poisonous substances, painting the spikes with poisonous baits and deterrents, and light traps.

Tirathaba sp. near *trichogramma*, Meyr. The "Greater" Coconut Spike Moth. [*Pyralidae*].

Observations concerning this insect, which is generally distributed throughout Malaya, are being made in conjunction with *Batrachedra arenosella*, Walk.

This moth lays its eggs on the opened flowers of the spike generally where the buds overlap one another.

Preliminary breeding work shows that the minimum length of time from egg to adult is 28 days and the maximum 43 days.

The caterpillars of this moth usually feed on the male flowers. They are active and form a gallery of excrement through which they advance or retire when disturbed.

Pupation takes place on the spike or on the spathe or at the base of the spike where, owing to the fallen flowers collecting there, the larvae are able to reach maturity.

The control for this insect should, until more definite information has been obtained, take the form of freeing the palms from all badly attacked spikes and all accumulated fallen flowers at the base of the spike.

Erecthias flavistriata, *Lyonetiidae*, Wals. and *Pyroderces ptilodelta*, *Cosmopterygidae*, Meyr.

The caterpillars of both these moths feed on the opened coconut spike, but their economic importance has not been established. It is probable, since they have been obtained from old spikes that they feed on the decayed portions of the coconut spike.

Insects of Padi.

Leptocorisa varicornis, Fb. The Padi "Fly."

This padi bug, *Leptocorisa varicornis*, known locally as "Pianggang," is forming one of the principal entomological investigations of insects injurious to padi.

The nymphs and adults live throughout the year on the inflorescences of wild grasses by sucking the sap from the developing seeds. The adult attracts attention when it migrates to the padi as the grain begins to form.

The inflorescences of the following wild grasses have been found to give suitable nourishment for the development of this insect from the hatching of the egg to the adult condition :—

1. *Panicum colonum*, Linn.,
2. *Paspalum platycaula*, Linn.,
3. *Paspalum conjugatum*, Berg.,
4. *Eleusine coracana*, Gaertn.,
5. *Andropogon sorghum*, (L) Brot.,
6. *Pennisetum typhoideum*, Rich.,
7. *Panicum crus-galli*, Linn.,

Eleusine indica, Gaertn. and *Eleusine aegyptiaca*, Desf. have not been found suitable.

The eggs which resemble small black seeds are laid in rows on the padi leaves and hatch in from 6-8 days. The young bug is similar to the adult but without wings and feeds by piercing the developing grain or stems and sucking the juices.

From the hatching of the egg until the adult condition is reached there are five moults. From 16-20 days are passed in the nymphal stages making a variation of 22-28 days for the life cycle.

Eggs have been found parasitised by a small Chalcidoid and the nymphs and adults are reduced in numbers by a Reduviid bug.

The most important result obtained during these investigations is the wide variety of food plants utilised by this insect.

This shows the necessity of keeping down grasses in the vicinity of padi areas, both when supporting padi and when fallow, in order to reduce the number of *Leptocorisa varicornis* attacking the next padi crop.

Podops coarctata, Fb.

This bug, known as "Kutu bruang" in Malaya, has been studied in detail, and a manuscript concerning its life history and control has been prepared for publication.

The principal results obtained from this investigation are:

(1) *Podops coarctata* may entirely prevent the formation of padi grain by sucking the sap from the stems of the plants.

(2) The eggs are laid in groups generally at the base of the stems but may be deposited in the soil or further up the stems.

(3) The majority of the eggs hatch in 4 days, though there is a variation of 3-6 days for the incubation.

(4) The largest number of eggs found in one group was 66 but the average was 38.

(5) The bug moults five times before attaining the adult or winged stage. The shortest time found for the nymphal stages was 29 days. First stage nymph 3 days, second stage 5 days, third stage 6 days, fourth stage 7 days, and the fifth stage 8 days.

(6) *Podops coarctata* has been found on "Rumput Gumpai" (*Panicum auritum*) and "Rumput Sendayan" (*Carex sp.*), in swampy places on grasses, on both dry and wet padi in the nursery and field, on every part of the padi plant including root and leaf, in cracks in the soil, under heaps of partially decayed padi and grasses prior to and after transplanting, under lumps of earth after the land has been ploughed for the next padi crop, and between padi crops on volunteer padi, padi stubble, and grasses.

(7) *Podops coarctata* has to be in large numbers for padi to show serious injury but in small numbers there is always a reduction in the yield of grain.

(8) *Podops coarctata* would seem to thrive best where there is stagnant water, and worst where conditions are dry.

(9) A Chalcidoid parasite has been observed as an enemy of the eggs of *Podops coarctata*. This parasite may complete its life

cycle in 7 days from the time of depositing an egg in the egg of the bug.

(10) Eggs collected have shown a percentage parasitisation of 72.9. This illustrates the influence that this parasite has in controlling "Kutu bruang" when it is present.

(11) The control of this insect should take the form of preventing as far as possible volunteer padi and grasses growing between padi crops, collecting egg masses from seedlings before and after transplanting and placing them in parasite cages, and spraying with tuba root extract where plentiful. If water is available flooding the area and collecting nymphs and adults from the surface has proved effective.

Diatraea auricilia, Dudgeon.

This insect until comparatively recently was an unrecorded pest of Padi in Malaya. It is generally distributed and the injury is caused by the caterpillars "boring" the padi stem.

The eggs are frequently highly parasitised. They should be collected and placed in suitable receptacles allowing the parasites to emerge and continue their useful control work.

Sufficient material has been obtained for a special bulletin on this insect.

Insects on Rubber.

The majority of insects on rubber are of very little importance and no insect of economic significance attacking rubber has been recorded during the year.

Below will be found a list of some of the insects which have been reported or observed during the year on "Hevea" and its products.

From Flowers.

Eurystylus sp. [*Capsidae*].

Hemithea costipunctata, Moore. [*Geometridae*].

Euproctis scintillans, (?) Walk. [*Lymantriidae*].

From Budded Rubber.

Epilachna indica, Muls. (reported). [*Coccinellidae*].

From Leaves.

Hypomeces squamosus, F. [*Curculionidae*].

Tiracola plagiata, Walk. [*Hadenidae*].

From Trunk.

Platypus lepidus, Chap. [*Scolytidae*].

Various caterpillars of moths (unidentified) feeding on lichens and tapping surface.

From Dead Trunk.

Clitellaria obesa, Walk. [*Stratiomyidae*].
Aulana confirmata, Walk. [*Stratiomyidae*].
Atractocerus emarginatus, Cast. [*Lymexylonidae*].
Omadius seticornis, Westw. [*Cleridae*].
Caenorychodes serrirostris, F. [*Brenthidae*].
Anancylus griseatus, Pasc. [*Lamiidae*].

From Decayed Rubber Seed.

Doloessa viridis, L. [*Pyralidae*].
Tenebroides mauritanicus, L. [*Trogositidae*].

From Rubber Seed Oil Cake.

Tribolium castaneum, Hornst [*Tenebrionidae*].
Araecerus fasciculatus, de Geer. [*Anthribidae*].

Slugs on Rubber Trees.

Slugs were found to be the cause of considerable damage to about 64 acres of young rubber by ascending the rubber trees at night and eating the buds. In their place adventitious buds developed which in turn were attacked so that the branches eventually assumed a truncated appearance.

The damage was considerable and growth had been retarded.

In the day time the slugs were found under the protection afforded by various cover crops and weeds.

Miscellaneous.

Necrobia rufipes, Fb. "Red legged Ham beetle".

This bright blue beetle is cosmopolitan and has been reported in ham, bacon, fish manure, hides of animals, bones, dried blood, copra, and such like materials.

This insect came to the notice of the Agricultural Department, not on account of its damage to copra, but owing to its being a nuisance in bungalows in the vicinity of copra stores.

This insect has been successfully bred from egg to adult on copra but it is generally recognised as predaceous.

The beetle and larva are more abundant in copra which has been undercured or kept in store.

Preliminary life history studies show that eggs are laid in groups. The eggs hatch in 4 days, the minimum time for the larval stage 69 days, and the minimum time in the cocoon 15 days, making a

minimum of 88 days from the laying of the egg to the emergence of the adult from the cocoon. In the cocoon, there are inactive larval, pupal, and inactive adult stages.

Control.

Adults are attracted to Light Traps but it is doubtful if this method of control can be considered effective.

Copra containing adults and larvae was fumigated for 24 hours with Hydrocyanic acid gas, prepared from the generally accepted formula for fumigation purposes.

When the copra was examined, all beetles and larvae were found to be dead, demonstrating the effectiveness of fumigation, but the expense of building a fumigating room (or of buying tarpaulin), of handling and of purchasing material would be very heavy.

The copra was examined by the Agricultural Chemist, who stated in his report that the Prussic acid found in the fumigated copra after exposure to the atmosphere for 24 hours was 1 part in 250,000, for 48 hours was 1 in 500,000, and for 48 hours followed by exposure to the sun for one day and then exposed to the atmosphere for a further three days was nil.

He concluded his report as follows:--

"The results indicate that, by exposing the copra to the sun and atmosphere as above, prussic acid is eliminated. After the fumigation period, the copra should be spread in thin layers in the open, provided the weather is dry."

Grasshoppers.

Two local outbreaks of grasshoppers have been reported.

The grasshopper, which increased to large numbers at Sepang, was *Orthacanthacris nigricornis*, Burm.—a generally distributed species throughout Malaya.

Grasshoppers recently reported at an estate on the Bernam River have not been received. This insect is probably *Cyrtacanthacris luteicornis*, Serv.—a grasshopper which was reported doing damage to coconut palms in 1921 at Kuala Selangor.

Prays citri, Mill.

The caterpillars of this small moth are found feeding in the rind of Limes. After decay has commenced a small Nitidulid beetle (*Carpophilus dimidiatus*, F.) and maggots of the fly, *Drosophila lurida*, Walk. are frequently seen. The original damage is caused by *Prays citri* and control measures only concern this insect.

Crocidomera robusta, Moore.

The caterpillars of this moth are frequently found boring the fruits of various Citrus plants.

The first consideration in the control of this insect is to collect and dispose of all attacked and fallen fruits.

Cephonodes hylas, Linn.

Observations on this insect have been made.

This hawk moth may be seen during the middle of the day flying actively and laying its eggs on the leaves of Coffee.

The eggs are laid singly on any convenient part of generally the most tender leaves. The majority of eggs are deposited on the upper surface of the leaf. The eggs hatch in 3 to 4 days and the larvae are full grown in from 18-21 days when they enter the soil and, having made a cocoon, change to pupae. The pupal stage lasts from 11 to 15 days.

Collecting the pupae from the soil and destroying them and spraying the trees with Lead Arsenate at the rate of 2 lbs to 50 gallons of water has proved successful in the control of this insect.

Phragmataecia parvipunctus, Hampn.

This moth belongs to the family *Cossidae* and the caterpillar bores in sugar-cane in Malaya.

Our records do not show this insect occurring as a pest in other countries.

Earias fabia, Stoll. and *Earias insulana*, Boisd.

The caterpillars of these two moths have been observed on several occasions damaging the "bolls" of Cotton.

Erionota thrax, Moore.

The caterpillars of this butterfly are responsible for rolling Banana leaves in Malaya. Under the protection of the rolls the caterpillar feeds and ultimately changes to a pupa.

The egg hatches out in about 5 days, the larval stage lasts about 25 days and the pupal stage 10 days making a total of about 40 days for this insect to complete its life cycle.

The eggs are very conspicuous on the leaves and should be hand collected before damage by the caterpillar is done. All rolls should be cut off, but since the larvae are often very highly parasitised, they should be placed in properly constructed boxes to allow the parasites to emerge.

Epilachna indica, Muls.

This insect which is a Coccinellid pest of Brinjal, *Datura* and related plants has been given attention and will form the subject matter of an article in the Malayan Agricultural Journal.

Termites. (White Ants).

Enquiries concerning white ants in buildings have received attention.

(4). IDENTIFICATIONS.

Most insects of considered economic importance to plants have been now identified by the officers of the Imperial Bureau of Entomology.

(4) FUTURE INVESTIGATIONS.

Detailed entomological investigations have been confined to the principal insects on coconuts and padi, but during the coming year studies of the major pests of cotton and sugar will receive greater consideration.

Insecticides will form a prominent part of the entomological programme.

ANNUAL REPORT OF THE AGRICULTURIST FOR 1922.

By F. G. Spring.

Mr. Spring, Agriculturist was in charge of this section of the Department throughout the year.

Mr. T. D. Marsh, Assistant Agriculturist was in charge of Kuala Lumpur, and Batu Tiga Experimental Plantations, until the 13th of July, when he took over charge of Castleton Estate, Teluk Anson.

Mr. Curtler, Assistant Agriculturist assisted the Agriculturist at headquarters from the date of his appointment until the 1st of June, when he was transferred to the Experimental Plantation, Serdang.

Mr. E. Farquharson, Assistant Agriculturist was in immediate charge of the Gunong Angsi Experimental Plantation, the Public Gardens, and the grounds around Government House, Carcosa, and the Sultan of Perak's Lodge, Kuala Lumpur; but took on additional duties at headquarters when the two officers referred to above were transferred.

Mr. E. Mathieu remained in charge of the Government Plantation, Kuala Kangsar, throughout the year.

The Experimental Plantations at Batu Tiga, and Gunong Angsi, were closed on the 1st of August, and 21st September, respectively. All seedlings of economic importance in the nursery beds at Batu Tiga, were removed to the Kuala Lumpur Gardens and a good stock of seed obtained from trees growing there.

Experimental Plantations.

The following shows the expenditure and receipts from the Experimental Plantations Kuala Lumpur, Kuala Kangsar, Batu Tiga, and Gunong Angsi, during the year.

Total upkeep expenditure, Experimental Plantation, Kuala Lumpur	$18,393.52
Total upkeep expenditure, Experimental Plantation, Kuala Kangsar ...	4,671.94
Total upkeep expenditure, Experimental Batu Tiga	4,623.14
Total upkeep expenditure, Experimental Plantation, Gunong Angsi ...	5,116.58
Receipts of Rubber sold	2,831.37
„ plants and seeds sold ...	2,976.98
„ total produce	5,808.35

The amount of rubber, in store, at the close of the year was approximately 8,435 lbs.

All buildings were maintained in thorough repair, whilst roads. and drains, were kept in good condition.

General Information.

The special feature in respect of agriculture, during the year has been the interest shown in crops other than rubber and coconuts.

Lectures on the elementary principles of Agriculture were given to Malay Probationers employed by the Department.

Malayan-Borneo Exhibition.—Messrs. Spring and Farquharson were on duty in Singapore in connection with this exhibition. Growing specimens of various fibre-producing plants, oils, cover crops, catch crops and grasses were exhibited also samples of the products. prepared from the respective crops. Photographs of the plants were also shown. Articles were contributed on the following subjects for the Handbook of Malayan Agriculture:—Agricultural Practice in Malaya, Cereals, Vegetables, Rubber, Oils, Fats, Fibres and Possibilities of other crops of economic importance.

Mr. Spring continued to act on a Committee for the management of the Batu Caves Tamil Settlement and was Honorary Secretary of the Gardens Committee.

The nursery beds at Kuala Lumpur Experimental Plantation, were considerably extended. Many of the old nurseries were planted up with legumes for the purpose of green manuring, other plots received an application of cattle manure.

A price list of economic, and non-economic planting material, as supplied by this Department was prepared and published in the Malayan Agricultural Journal.

A visit was made to Tanjong Rambutan Experimental Farm attached to the Central Mental Hospital with the object of advising on experimental work which is being conducted there.

The Agriculturist acted as one of the judges at the Agri-Horticultural Show, Rembau.

Many visits were made to estates in connection with general agricultural matters. The various Government Plantations were inspected periodically as well as the grounds of Government House, Carcosa and the Sultan of Perak's Lodge, Kuala Lumpur. The grounds referred to were maintained in good order throughout the year.

Twenty acres of rubber trees at Weld's Hill, Kuala Lumpur, were cut out. Approximately 50 acres of blukar land situated in Carcosa domain, were cleared.

RUBBER.

The systems of tapping in use, to-day, are all on conservative lines as compared with former years. Alternate day tapping is rapidly gaining favour, over daily, and there is much to be said in its favour. One quarter cut is perhaps the most popular system, but one cut on a third, and half spiral, are commonly used.

Tapping experiments were continued. An experiment, to compare the yield obtained from individual trees of various ages, was commenced in the early part of the year and records kept. The object of this test is to select high yielding trees for purposes of bud-grafting. A large number of seedlings have been raised for carrying out this work.

Many demonstrations on bud-grafting of Hevea were given at headquarters and several on rubber estates, throughout the country.

COVER CROPS.

It is satisfactory to be in a position to report that there have been more applications for seed of cover crops than in previous years. The growing of cover crops is rapidly gaining favour and their value as green manure and as a means of reducing soil wash is now recognised. On good quality land, *Centrosema Plumieri* is the most satisfactory cover, but unfortunately this legume will not flourish on poor soil. On the poorer soils, the Giant mimosa (*Mimosa invisa*) thrives best and can be recommended for improving the mechanical condition of the soil and reducing surface wash. The Sarawak Bean thrives well on the lighter types of soil which contain a fair proportion of humus.

PREVENTION OF SOIL WASH.

There is little that can be added to my report of last year, except that I would again like to draw attention to the necessity of doing everything possible to prevent, or at least reduce, surface erosion.

FIBRES.

A great deal of interest has been shown in the local production of the chief fibres of commerce and special reference might be made of the Roselle fibre in this direction,

Roselle Fibre.—A large stock of Roselle seed has been raised and seventy-four applicants were supplied with planting material and nine applicants with commercial samples of the prepared fibre. There is now a large stock of seed in the country, sufficient for future planting. Several estates have grown this crop satisfactorily, but mention might be made of one estate in Perak where it has already proved a financial success. This property has placed on the market excellent ropes made from Roselle fibre for which there appears to be a good demand. A commercial sample of this fibre grown and prepared by the Department of Agriculture was forwarded to Denmark, and an exhibit of the fibre and rope was prepared on behalf of the

Imperial Institute. Recent experiments have shown the advisability of close planting and it is recommended to broadcast the seed, on a well prepared surface, at the rate of about 20 lbs. to the acre. It is not possible yet to state the type of land best suited for Roselle but it might be mentioned that good growth has been attained on the lighter type of soils. Roselle fibre seems well adapted to Malayan conditions and can be grown on a large, or on a small scale. Roselle is a suitable crop for the small holder, as quick returns are obtainable and machinery is not essential for the manufacture of the fibre. There would appear no reason why ropes should not be manufactured in Malaya and it is hoped that ultimately this industry may be developed to an extent that will, at least, satisfy local requirements.

Bowstring hemp (*Sanseviera sp.*) —The results of experiment show that Bowstring hemp is a very slow grower, and on that account, it is questionable whether it will prove commercially profitable under estate conditions. It thrives well under the shade of old rubber trees, but appears to be of slow growth under any conditions. Samples of Bowstring hemp were forwarded to the authorities at Kew Gardens for identification.

Sisal hemp (*Agave rigida var: sisalana*).—There is no doubt that Sisal can be grown satisfactorily, in the Malay Peninsula, but it must be grown on a large scale of several thousand acres to warrant the introduction of expensive machinery required for preparing the fibre. The same remarks apply to Mauritius hemp (*Furcraea gigantea*). Three estates are growing Sisal hemp experimentally.

Manila hemp (*Musa textilis*).—Seven applicants were supplied with suckers of Manila hemp. A good stock of plants were raised at headquarters and planted out at Serdang Experimental Plantation.

Kapok (*Eriodendron anfractuosum*).—A stock of seed from good yielding trees was obtained from Kuala Kangsar and supplied to eight applicants. Kapok produces very little shade and catch crops should certainly be interplanted. There is little further to state than that contained in my annual report of last year.

TOBACCO.

A certain amount of interest has been taken in the cultivation of tobacco for second grade cigars. The Straits and Burma Trading Co., of Kuala Lumpur import Dutch and Burmese tobacco leaf and manufacture the cigars in Kuala Lumpur. It is proposed to provide this company with material grown by the Department and to encourage the local production of the leaf. There have been one or two enquiries regarding the growing of tobacco for the preparation of extract.

TUBA ROOT (*Derris elliptica*).

The Ministry of Agriculture and Fisheries, London, report that there is, as yet, no trustworthy information concerning the relative toxic contents of different species of Derris or of the varieties of the

species *Derris elliptica*, since botanic specimens have not been obtainable. Every endeavour is to be made by this Department to obtain suitable botanical specimens for purposes of identification. The Ministry further estate that it is at present too early to answer definitely as to the probable demand for the product; but there is no doubt that Derris has valuable insecticidal properties and that it will take its place among the older insecticides, if it is handled in a sound manner from the commercial point of view. An article on Derris carried out jointly by the Ministry's Pathological Laboratory and the Rothamsted Experimental Station will appear in a forthcoming number of the Annals of Applied Biology. This crop can be successfully grown in Malaya and is extensively used by Chinese market gardeners as an insecticide.

Fruit.

A large supply of planting material of various fruits was obtained and it is hoped to maintain a sufficient stock to meet future demands. A good deal of interest has been taken in the growing of fruits and many applications were received for planting material; 2172 seedlings were supplied to 32 applicants. The Agriculturist inspected a fruit plantation belonging to a Chinaman of Singapore and found that this gentleman is growing a remarkably fine orange which appears to be much in demand in Singapore. Marcotted plants can be obtained at $1/- each. This gentleman is also producing quite a good fig. Several estates were visited in connection with fruit cultivation and an additional area, in the Kuala Lumpur Gardens, was planted up with a collection of fruits of good varieties. The Brazil nut trees, in the Kuala Lumpur Gardens, are now fruiting and this, the first crop, is quite satisfactory. The trees are remarkably healthy and are undoubtedly well suited to Malayan conditions. The Department is keeping in touch with the growers of good stock and recommending applicants, who apply for seedlings, to good sources of supply. Fruit culture, in this country, has received little attention. The general method of raising stock has been by seed and little attention has been given to selection. It is unusual for a selected variety to come true to seed consequently some other form of vegetative reproduction is desirable. Some fruits may be reproduced by cuttings, others by layering and marcotting, but the most satisfactory results are by budding and grafting. The importance of improving local fruits is fully recognised by the Department and it is proposed to devote a great deal of time to this branch of agriculture.

Pasture and Fodder Grasses.

An estate in Malacca was visited in this connection and the following grasses planted:—Soudan, Guinea, Australian Blue Couch, Natal Red Top and *Paspalum dilatatum*. All of the above mentioned grasses have done well in the Government Plantations. Any planter wishing to establish a grazing, or fodder grass, should communicate with this office. A great deal can be done to improve our local grasses by cultivation and manuring.

Peas and Beans.

An endeavour is being made to encourage the local production of peas and beans by Chinese market gardeners. The Agriculturist had an interview with the Protector of Chinese and Collector of Land Revenue in this connection.

African Oil Palm (*Elaeis guineensis*).

The yields of the African Oil Palms at Kuala Lumpur Gardens were recorded. This area was manured with vegetable refuse which was turned into soil.

Citronella Grass (*Andropogan Nardus*).

435 lbs. of Citronella grass were supplied to the Agricultural Chemist for experimental purposes.

Exhibits sent to the Imperial Institute, London.

Ground Nut (*Arachis hypogaea*).

Green Gram (*Phaseolus Mungo*).

Cow Pea (*Vigna Catjang*).

Chillies (*Capsicum sp:*).

Lima Bean (*Phaseolus lunatus*).

Black Gram (*Phaseolus Mungo var: radiatus*).

Pogostemon Patchouli, leaves and botanical specimen.

Kapok.

Sea Island Cotton.

Mauritius Hemp (*Furcraea gigantea*) rope.

Mauritius Hemp (*Furcraea gigantea*) fibre.

Sisal Hemp (*Agave rigida var: Sisalana*) rope.

Sisal Hemp (*Agave rigida var: Sisalana*) fibre.

Bowstring Hemp (*Sanseviera sp:*) rope.

Bowstring Hemp (*Sanseviera sp:*) fibre.

Roselle (*Hibiscus Sabdariffa var: altissima*) rope.

Roselle (*Hibiscus Sabdariffa var: altissima*) fibre.

Coconut (*Cocos nucifera*) rope.

Bombay Hemp (*Hibiscus cannabinus*) rope.

Manila Hemp (*Musa textilis*) rope.

Pineapple (*Ananas sativus*) rope.

Ipecacuanha (dried roots).

ANNUAL REPORT OF THE AGRICULTURIST, GOVERNMENT PLANTATIONS, FOR 1922.

By

B. Bunting.

Staff.

Mr. B. Bunting, Agriculturist, was responsible for the administration of the Government Plantations Pondok Tanjong, Kuala Tembeling, Castleton Estate, Telok Anson, the Experimental Coconut Plantation Sapintas, and the Experimental Plantation, Serdang, and was assisted by Messrs J. N. Milsum, T. D. Marsh and E. A. Curtler, Assistant Agriculturists, and J. Lambourne, Superintendent, Government Plantations.

Mr. Lindsay Vears, Manager, Experimental Plantation, Serdang, left the service on the termination of his agreement on the 18th June.

Mr. J. Lambourne, Superintendent, Government Plantations, proceeded on leave on the 18th July and Mr. T. D. Marsh, Assistant Agriculturist, took over charge of Castleton Estate, Telok Anson, as from that date.

Expenditure and Revenue.

The following shows the expenditure and revenue, both estimated and actual, of the Government Plantations Pondok Tanjong, Kuala Tembeling, Castleton Estate, Telok Anson, the Experimental Coconut Plantation, Sapintas, and the Experimental Plantation, Serdang, during the year.

Expenditure.

	Estimated.	Actual.
Government Plantation, Pondok Tanjong ...	$ 32,000.00	$ 30,587.85
Government Plantation, Kuala Tembeling ...	30,000.00	28,070.72
Castleton Estate, Telok Anson ...	32,750.00	25,248.56
Experimental Plantation, Sapintas ...	80,000.00	75,313.89
,, ,, Serdang ...	87,500.00	77,314.34
	$262,250.00	$236,535.36

Revenue.

	Estimated.	Actual.
Government Plantation, Pondok Tanjong ...	$ 23,400.00	$ 31,919.38
Government Plantation, Kuala Tembeling ...	150.00	176.61
Castleton Estate, Telok Anson ...	29,600.00	28,130.41
Experimental Plantation, Sapintas ...	4,160.00	4,130.93
,, ,, Serdang ...	474.00	456.60
	$ 57,784.00	$ 64,813.93

The total expenditure for the above Government Plantations for the year was $236,535.36 against $295,557.11 in 1921 which is a reduction in expenditure of $59,021.75, whilst the total revenue for the year was $64,813.93 against $43,451.63 in 1921, or an increase in revenue of $21,362.30.

The reduction in expenditure is due partly to the policy of cutting out a certain amount of development work, which automatically reduced the labour requirements of some of the plantations, and partly to the lower cost of materials for the period under review.

The increase in revenue is attributed to the higher prices obtained for the sale of rubber during the latter part of the year.

GOVERNMENT PLANTATION, PONDOK TANJONG.

Mr. F. W. McCormac was in charge of this plantation throughout the year.

The area of the plantation is approximately 584 acres, which is made up as follows:—

Mature rubber	...	271 acres.
New clearings	...	300 ,,
Building sites	...	7 ,,
Waste land	...	6 ,,

General curtailment of expenditure necessitated the cutting out of all development work on this plantation and the Estimates of Expenditure were reduced accordingly, resulting in a saving of $26,000.00 which had been allowed for this work.

The planted area has been improved during the year by thinning out a number of inferior trees and is now in excellent condition.

With the exception of about 60 acres of low-lying land, liable to flooding, the whole of the mature area was weeded at a cost of 22.5 cts. per acre per month, which gives a figure of $2.70 per acre per annum against $5.02 for the previous year. The weeding of the new clearings, which have been planted up with *Centrosema Plumieri*, cost only 42 cts. per acre per month.

The labour force at the end of the year was made up of 100 Tamils—59 males, 24 females and 17 minors—and 2 others or a total of 102 coolies, which is sufficient for present requirements. The average daily check-roll wages throughout the year was 37.99 cts. per coolie.

The health of the labour has been good and has shown a decided improvement on last year. There were 128 admissions to hospital and 1 death during the year.

All buildings were maintained in good repair throughout the year at very little cost.

The whole of the planted area (271 acres) is in bearing and the system of tapping is one cut on a quarter tapped on alternate days, except for two small areas which are still on one cut on a third alternate days.

A crop of 94,675 lbs of dry rubber was harvested during the year which was collected at a cost of 4.34 cts. per lb. The "all-in" cost for the year was 19.92 cts. per lb against 44.42 cts (under voluntary restriction) in 1921, whilst the average price realised for all grades was 34.38 cts. per lb. compared with 29.27 cts for 1921.

Out of the 20 consignments of rubber despatched to the Singapore Auctions 15 were awarded the Singapore Standard price for Smoked Sheet.

A tapping experiment was inaugurated in July in order to test the relative value of the alternate day and periodic resting system of tapping. Two of the controls are being tapped on alternate days and the other three plots will be tapped alternately for a period of 12 weeks, the experiment being so arranged that one of the three plots under periodic resting will always be tapped over the same period as the controls.

Diseases and pests give a certain amount of trouble but are kept well under control. Pink disease (*Corticium salmonicolor*) and *Ustulina zonata* are the most prevalent, but a fair number of cases of Brown Bast have occurred.

White Ants (*Termes gestroi*) appear to give very little trouble.

Rain was recorded on 191 days during the year giving a total rainfall of 142.04 inches.

Government Plantation, Kuala Tembeling.

Capt. F. J. Ayris acted as Manager of this plantation throughout the year.

The area of the plantation is approximately 930½ acres, which is made up as follows:

Mature rubber	...	325 acres.
Immature rubber	..	131½ ,,
Cleared but not planted	...	11 ,,
Building sites	...	9 ,,
Reserve land	...	454 ,,

The general appearance of the whole of the planted area is excellent and the rubber trees in both the mature and immature fields look extremely healthy.

A census of the number of tappable trees taken in December showed that 21,903 trees had attained a tappable size on that date.

Most of the immature area is planted with *Centrosema Plumieri* and this leguminous plant produces an excellent cover on this type of land.

The everage cost of weeding the mature area (part clean weeded) was $1.00 per acre and the immature area (part strip-weeded) $3.21 per acre per month repectively. With increased shade produced in the young areas future weeding costs should be considerably reduced.

Roads, drains and bridges have been kept in good condition throughout the year.

The labour force at the end of the year consisted of 97 Tamils—67 males, 24 females and 6 minors and 2 Bengalis or a total of 99 coolies. The average daily check-roll wages throughout the year was 45.71 cents per coolie.

The health of the labour force has shown further improvement and is now very good indeed. There were 63 admissions to Hospital and 3 deaths during the year.

All buildings were maintained in fairly good condition but will require attention next year.

A certificate of Standard Production was obtained allowing for the export of 106,960 lbs. of dry rubber in respect of this plantation, but it was considered more economical to produce this rubber on other Government plantations where experiments in tapping, etc., were being carried out.

Diseases and pests are kept well under control. A few cases of Pink disease have been reported from time to time, whilst isolated trees were attacked with White ants.

Rain was recorded on 169 days during the year, giving a total rainfall of 101.52 inches.

CASTLETON ESTATE, TELOK ANSON.

Mr. J. Lambourne, Superintendent, Government Plantations, was in charge of this estate until he proceeded on leave on the 18th July, when Mr. T. D. Marsh, Assistant Agriculturist, took over charge as from that date.

The area of the estate is 208 acres, which is made up as follows:—

Mature rubber	...	...	197	acres.
Coconuts	...	...	6½	„
Building sites	...	...	4½	„

The whole of the area under rubber is kept in a clean weeded condition. The average cost of weeding was 20.35 cents per acre per month or $2.44 per acre for the year.

The labour force at the end of the year consisted of 71 Tamils—55 males, 12 females and 4 minors—and 2 others, or a total of 73 coolies. The average daily check-roll wages throughout the year was $39.80 cents per coolie.

The general health of the coolies was very good indeed, there being only 4 admissions to Hospital and no deaths during the year.

All buildings were maintained in thorough repair and are sufficient for future requirements.

The whole of the planted area is in bearing and the system of tapping is one cut on the quarter daily. The total number of trees on December 31st was 16,307 or an average stand of 82 trees per acre.

The amount of dry rubber harvested during the year was 88,261 lbs., which is equivalent to an average yield of 447 lbs. per acre per annum.

The average cost of tapping and collecting was 6.5 cents per lb. whilst the "all-in" cost of production was 29.08 cents as against 37.36 cents in 1921. This includes all experimental tapping which is responsible for the comparatively high costs under this heading.

The experiments on different systems of tapping, individual yield of trees, various methods of cultivation, and the effects of thinning-out on yield of rubber were continued throughout the year.

A few small trial plots of minor economic crops interplanted amongst the coconuts were laid down from time to time and the results of these trials carefully recorded.

Diseases and pests were kept under control. Brown Bast and *Sphaerostilbe repens* have been recorded from time to time as well as isolated cases of Die back (Diplodia).

White Ants do not give very much trouble.

Rain fell on 168 days during the year, giving a total rainfall of 90.40 inches.

Experimental Coconut Plantation, Sapintas.

Mr. F. G. Parkin has been in charge throughout the year: Mr. F. J. Norman, Temporary Assistant, resigned his appointment on the 5th April.

The area of the plantation is 2122½ acres, which is made up as follows:

Coconuts	...	938.1 acres
Rubber	...	88.6 ,,
Cleared but not planted	...	64.3 ,,
Felled and part cleared	...	67.1 ,,
Building sites	...	17.3 ,,
Waste land	...	45.5 ,,
Reserve Land	...	901.6 ,,

In view of the necessity for curtailment of expenditure all development work was suspended and, with the exception of supplying a number of vacancies in the selection block, no planting was done during the year under review.

The general appearance and growth of both the old and young coconuts areas has shown considerable improvement. Of the young areas of coconuts (tall variety), planted in October—November 1919 and January 1920, a number of palms are already flowering and the same applies to the Dwarf or King coconuts planted in September to December 1920.

The area under rubber has also shown improvement and a census of the tappable trees taken in August showed that there were 3660 trees of a tappable size on that date.

Of the area planted with coconuts approximately 306 acres were under Giant Mimosa (*Mimosa invisa*), 109 acres under experimental cover crops (various types), 27 acres under sweet potato (*Ipomea batatas*), 178 acres clean weeded and the remaining 318 acres under grass weeding.

The whole area planted with rubber is under Giant Mimosa, but owing to the increased shade produced by the trees it is now gradually dying out.

The average cost of weeding the whole of the coconut area was $1.64 per acre and the rubber area $1.03 per acre per month, respectively. This is perhaps a rather high figure but in view of the heavy nature of the soil, which necessitates fortnightly weeding on the clean weeded areas, it cannot be considered excessive.

Lalang is troublesome in the areas under grass, but has been kept well under control.

The experiments with various leguminous and non-leguminous cover crops were continued and the following covers were under trial at the close of the year: *Centrosema Plumieri*, *Mimosa invisa*, *Clitoria cajanifolia*, *Dolichos hosei*, *Tephrosia candida*, *Sesbania aculeata*, Passion flower and Sweet potato. The area under experiment, including 4 clean weeded controls, was approximately 72 acres.

The cleaning out and deepening of the field drains on an area of 543 acres was completed during the year, in addition to scupper draining a further area of about 250 acres. This has resulted in a considerable improvement in the drainage system and its effect should be shown in the increased growth of the palms in the near future.

The foundations of the watergate erected in Fields 1—2 collapsed in March and as it could not be repaired it was found necessary to erect a new gate further back from the river. This is now working satisfactorily.

Mounding and ridging was carried out on the low-lying peat area and should prove beneficial to the palms which were beginning to fall over in this area.

The roads and bridges have been kept in good condition.

Stacking and burning of timber on an area of about 225 acres was completed during the year and the whole estate is now practically clean cleared of all timber.

Supplying was carried out where necessary and altogether 6536 vacancies were supplied in the coconut area.

The labour force at the end of the year consisted of 358 Tamils —242 males, 77 females and 40 minors—and 2 Malays, or a total of 360 coolies which is a reduction of nearly 200 on the total employed on the same date last year. The average daily check-roll wages throughout the year was 37.72 cents per coolie.

The general health of the coolies continues to be very good. There were 105 admissions to Hospital and 10 deaths, 4 women and 6 children, during the year.

Buildings were maintained in thorough repair and the corrugated iron roofs were repainted where necessary.

A crop of 120,608 nuts was harvested during the year against an estimate of 96,000. Of the crop harvested 118,233 nuts were made into copra, producing 452.73 piculs, which was sold at an average price of $8.99 per picul. The balance of 2375 nuts were sold at an average price of 2.53 cts. each.

The total amount realised for the sale of nuts and copra was $4130.90 against $1599.35 for the previous year.

The average number of nuts required to make a picul of copra was 261 which is fairly high on account of the large number of small nuts from palms just coming into bearing.

A census of the coconut palms taken in July showed that there were 6845 palms in bearing and a further 1994 palms flowering in Fields Nos. 1 to 12 (395.4 acres) which is nearly 50% of the palms on this area.

Diseases and pests on the coconut area give a little trouble, but are kept well in check by the pest gang. White ants and beetles are the most common, whilst locusts, which are harboured by the Giant Mimosa, have been responsible for the destruction of a number of supplies.

Pig and bear have also been very troublesome in the newly planted areas in spite of fencing precautions. Isolated cases of Bud-rot, Pestalozzia and Transverse leaf-break have occurred and been treated.

In the rubber area White ants have caused a certain amount of trouble, whilst a few cases of Fomes and Pink Disease have occurred from time to time.

Rain fell on 149 days during the year giving a total rainfall of 78.80 inches.

EXPERIMENTAL PLANTATION, SERDANG.

Mr. Lindsay Vears was in charge of this plantation until the 13th June, when Mr. E. A. Curtler, Assistant Agriculturist took over charge of the labour as from that date.

Mr. J. N. Milsum Assistant Agriculturist, remained in charge of the experimental work throughout the year and was transferred to the plantation on the 1st August.

The Agriculturist Government Plantations, who was held responsible for the general supervision of the work of opening up and laying out of this plantation paid regular weekly visits of inspection and devoted a large amount of time to superintending the various planting operations in progress during the year under review.

An area of about 350 acres of good flat land, particularly suitable for experimental work with annual crops, was added to the plantation during the year, which makes the total area of the plantation approximately 1525 acres, half of which is hilly land and the other half either flat or undulating.

At the close of the year there was an area of roughly 450 acres of land clean cleared of all timber and the major portion of it was either planted or prepared ready for planting. The greater part of this area having been ploughed by tractors the land was absolutely freed of all roots and timber, making it most suitable for the cultivation of annual crops which require replanting periodically.

A block of 10 acres was specially reserved for a permanent nursery for the propagation of planting material and the area was systematically laid out in half-acre plots, which are so arranged that they can be either reduced or increased in size according to requirements. Good wide roads have been placed through and round the area and a bamboo fence planted on all sides of the boundary.

An area of 50 acres has been specially reserved for an arboretum which will be planted up with small plots of trees and shrubs likely to prove of possible economic importance. Careful observation will be made of anything planted in this area and should any plant prove to be of economic value it will then be planted out on a field scale to test its possibilities from an economic standpoint.

Fairly extensive drainage operations were carried out during the year and in addition to draining the opened area of 450 acres the main drain round the boundary of the new 350 acre block was completed and as these drains have been thoroughly tested

during the recent wet season I am able to report that the whole of the drainage system is working most efficiently. The proper control of the water passing through the plantation has not only considerably improved the opened area but has had the effect of drying up the 350 acre block of unopened land on the Eastern boundary, part of which will be felled and planted next year.

Excellent progress has also been made in the construction of permanent connecting roads dividing up the different blocks on the opened area and these are gradually being covered with laterite as transport and labour permit of this work being carried out. On all roads constructed through the hilly or undulating areas a row of citronella grass has been planted on each side of the road to prevent any damage from wash. There is plenty of good laterite available on the plantation for the construction of roads for the transport of materials throughout the opened area.

With the exception of a few coolies employed on nursery work, there was no resident labour force on the plantation, and the work of opening up was done partly on contract and partly with casual Chinese labour engaged locally from day to day. The average number of coolies employed daily was 241 and the rate of pay averaged 45 cents per coolie per diem.

Although isolated cases of malaria were reported during the year the health on the plantation was fairly satisfactory.

Good progress has been made in the planting out of the various crops in the field and full advantage was taken of the favourable conditions for planting up the cleared areas during the wet seasons.

The following gives the approximate areas of the principal crops which had been planted out at the end of the year:—African Oil Palm 50 acres, Kapok 50 acres, Sisal Hemp 25 acres, Mauritius Hemp 25 acres, Sugar Cane (10 Malay and 13 Javanese varieties) 25 acres, Coffee (5 varieties) 10 acres, Croton oil 9 acres, Candle Nut 8 acres, Sugar Palm 7 acres, Coca (cocaine) 5 acres, Manilla Hemp 4½ acres, Sea Island and Egyptian Cottons 4 acres, Roselle Fibre 2½ acres, Bananas (approximately 100 varieties) 2 acres, in addition to an area of 10 acres, in the permanent nursery, planted with small plots of miscellaneous crops of which we have not yet obtained sufficient stocks of planting material to plant out on a field scale.

At the end of the year several fairly large blocks were prepared ready for planting and were only waiting more suitable weather conditions.

A collection of the local varieties of Bananas was increased from 46 to about 120 during the year and the different varieties are being isolated as soon as they fruit.

Sufficient stock of the different varieties of Sugar Cane (both Malayan and Javanese) has been obtained to plant up one acre blocks of each variety.

Every effort has been made to collect stocks of planting material for this new plantation and there were roughly 100 different species of plants established on the plantation at the close of the year.

A start has been made to form a herbarium collection of economic plants. A number of plants have already been mounted and will be added to as material becomes available. It is hoped eventually to have herbarium specimens of all the crops being cultivated at the Experimental Plantation.

Diseases and pests give a certain amount of trouble, but were kept well under control. The most serious pest was a swarm of caterpillars of *Tinacola flagiata* which attacked the Sisal Hemp, Mauritius Hemp and Kapok on the Eastern boundary of the unopened area. The caterpillars had been feeding on the adjoining blukar and having eaten most of its foliage passed on in a large army to the planted area.

Fortunately they were discovered before they had time to do much damage and were completely eradicated.

Rain fell on 199 days during the year giving a total rainfall of 87.86 inches. The low rainfall is somewhat compensated for by the large number of wet days.

GENERAL.

During the earlier part of the year a considerable amount of time of the officers of this division was devoted to the preparation and collection of exhibits for the Malay-Borneo Exhibition, in addition to the contribution of articles in connection with the Department publication of a handbook on Malayan Agriculture.

Further, the exhibition was responsible for a certain amount of disorganisation of both European and subordinate staff during the latter part of March and beginning of April as several officers were required to be in attendance at Singapore for this period.

A course of lectures in the elementary principles of Agriculture was given to a number of Malay apprentices and probationers attached to the Department. The students were very regular in their attendance of lectures and the results of the examination showed that the majority had attained a good knowledge of the subjects which were included in the syllabus.

Periodical visits were made to all the Government Plantations and reports on their condition were submitted to the Secretary for Agriculture from time to time.

ANNUAL REPORT OF THE AGRICULTURAL INSTRUCTOR, FOR 1922.

By

D. H. Grist.

1. *Organisation.*

The provision of an Instruction Division of the Department of Agriculture was approved on July 1st, 1922, as a provisional and tentative arrangement, subject to review on July 1st 1923. Under this arrangement the writer was placed in charge of the division, to be assisted by Captain Howlett as soon as he could be released from his duties in the library. Captain Howlett did not work in the new division during the year under review.

Under the scheme of organization, it was arranged that the Inspection staff should organise demonstration and experimental work, while under the Instruction division was placed such problems as school gardening, Malay literature, investigations on organization of local industries, literature for local shows, arrangements for examinations etc. of the Malay officers of the Department. In general terms the new division was to place the Department more closely in touch with the Malay cultivator. The work, while mainly connected with native effort, is not confined to such cultivators, for the consideration of the marketing of crops is often of lively interest to alien planters, and much benefit may on occasion result to native agriculture from the interest taken by European planters.

The Staff throughout the year has consisted of the writer and one Junior Agricultural Assistant.

2. *Kapok.*

The steady rise in price of this commodity in the world's markets was a feature of a year of general "Slump," and in consideration of the apparent suitability of Malaya for the cultivation of this crop, the question of its local production was investigated by the Division.

Statistics shewed that there are about 100,000 kapok trees in the Peninsula, about 60,000 of which are within a comparatively small area of Perak. While the actual number of trees is not great, yet it was thought that it was sufficient to justify an attempt at marketing, having regard to the immediate benefit accruing to the cultivator, and the value of this in stimulating the planting of new areas with the crop.

The Agricultural Instructor visited all the districts in Perak where the trees are numerous, and observed that while those of Krian were mostly planted in unsuitable situations, the trees along the Perak River and generally throughout Lower Perak were in a very promising condition.

The value of kapok is unappreciated by Malays, but is well known amongst the Chinese shopkeepers. The result is that little kapok is harvested, other than that required by the owner for his own use, unless its sale to the local shopkeeper is enforced in order to reduce the cultivator's debts to the shopkeeper. It follows that the Malay procures but a small price for his crop--actually about $5 a pikul for uncleaned kapok worth at present about $10—$12.

At the time of this investigation in Perak, the harvesting season was advanced, and, with the object of saving the crop and demonstrating its value, the suggestion was made that the Government might buy kapok at a fixed price, clean it in one of the convict establishments and place it on the local market. Government approval of this suggestion was received too late to put the scheme into operation.

An attempt is to be made to organize the collection, cleaning and sale of the crop in 1923. A European planter has agreed to buy at a fixed rate and carry out the necessary work of cleaning, baling, etc., and as he is situated at a convenient centre on the road, river and railway, there is reason to expect that this scheme will be successful.

Much information has been collected locally, and from other countries, on the cultivation, preparation of floss, and marketing of kapok, and this information has been written up for publication.* The local cultivation of kapok is of interest to all planters in this country because it is a crop conveniently grown in conjunction with other forms of agriculture, can be grown successfully in Malaya, is inexpensive in machinery, commands a ready local sale (Penang alone imported 170 tons in 1921) as well as being in world-wide demand. There was considerable enquiry amongst planters respecting kapok, and within the next two years there should be a largely increased area planted under this crop in Malaya.

3. *Roselle.*

The pros and cons of roselle have been the subject of much discussion during the year. The two main questions that confronted the prospective cultivator at the commencement of the year were:— Labour necessary, and uncertainty of market; and in the inter-relation of these two questions was bound up the whole matter of success or failure, of profit or loss. It was therefore encouraging to find one planter who, himself convinced of its possibilities, planted considerable areas, manufactured rope and string commercially and also sold raw fibre at a good profit in England.

Given the fact that the market was assured, the writer was convinced of the suitability of the cultivation of this crop on native holdings, because it can be made to pay on small areas, and requires absolutely no machinery in its production. A guaranteed price for roselle fibre has been offered by the aforesaid planter to Malays producing fibre, and a number of Malays have now this crop planted on their holdings.

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* Published in M. A. J. XI, No. 1.

While the Department of Agriculture is encouraging the cultivation of roselle amongst all classes of planters, it would appear that a certain amount of caution is necessary, for in the first place, the relative merits of this fibre in comparison to Jute (which is the standard) is still uncertain, for although it would appear that roselle is of better colour, it is said to be more brittle. And secondly, it is observed that roselle plants occasionally suffer very considerably from disease. Practically every plant on one demonstration plot in Ulu Selangor has died through this cause, and occasional attacks have been noted elsewhere. Either of these two causes may result in considerable loss to the planter, but it may certainly be urged that roselle demands a comparatively small outlay of capital and no machinery other than a baler, so that the risk is more restricted than is the case with many other crops.

4. *Exhibitions and Shows.*

Malaya-Borneo Exhibition: The writer was on the Agricultural Committee of the above Exhibition, and was Honorary Secretary of the Agricultural Show Sub-Committee organized in this connection. The Committee arranged, with the co-operation of all the officers in the Department, a departmental exhibit, which was one of the great attractions of the Malaya-Borneo Exhibition; and edited a Handbook of Malayan Agriculture. The Agricultural Show attracted about 15,000 exhibits from all parts of the Peninsula and Borneo.

Much of the writer's time in the first four months of the year was devoted to work in connection with the Exhibition.

The District Shows, provision for which appeared in the Estimates, were not held, owing to the necessity for curtailment of expenditure, consequently the Vote of $1000 which appeared in the Agricultural Estimates, for the provision of literature for these events was not expended.

Private effort is replacing the abandonment of Agricultural Shows under Government auspices. The Negri Sembilan Agri-Horticultural Society is flourishing and held successful shows in Negri Sembilan, while the Malayan Agri-Horticultural Association came into being in October. The aims of this Association are so closely related to some of the objects of this Division, that the writer accepted the invitation of the Association to the office of Honorary Organizing Secretary and Treasurer.

5. *School Gardens.*

Although the Scheme for school gardens was approved before the Instruction Division came into being, no funds were available for commencing the work until August, when the sum of $2,200 was transferred from another vote to the Instruction Division. This enabled a start to be made by the purchase of implements etc. A survey of the schools of Selangor, Negri Sembilan and part of Pahang was made, and the most suitable schools selected. The Agricultural Instructor then met the teachers concerned at Kuala Lumpur, and later, at Seremban, and explained to them the objects of School

Gardening and the method of starting the scheme. A limited number of implements were provided to each school on the register of school gardens, and suitable planting material was also supplied from time to time.

By the end of the year, eight schools in Selangor had started school gardens, and preparations were made for additional schools to commence the work early in 1923. The writer sees evidence of great keenness amongst the children, and a sympathetic interest amongst the teachers. It must be remembered that, at the Agricultural Instructor's suggestion, the system of school gardens was started before the teachers were trained in the work. It is too early to venture an opinion as to whether this step was justified. Much of the success depends on frequent visits to the schools by Agricultural officers, because the teachers rely on the Department for assistance in various directions in connection with the gardens.

6. *Warta Perusahaan Tanah.*

The first number of a Malay Agricultural Bulletin printed in the Arabic character appeared early in December, the edition being 2500 copies. It contained articles on kapok,--cultivation, harvesting and marketing: Roselle-Cultivation and marketing; The objects of School Gardens; a discussion on School Gardens by a Malay, and an Editorial.

Prior to the publication of this Bulletin the Division collected from the Districts a list of Malay Chiefs, Malay Government Officers, and other Malays of standing to whom the Bulletin should be supplied. In addition, a copy was sent to each school in the country. No charge to the reader was made for the publication, it being treated purely as propaganda work. The result was, in the writer's opinion encouraging, a number of letters were received from Malays in different parts of the country, either thanking the Department for the publication, or asking for further advice on cultivation, diseases and pests, and for the supply of seed. It is necessary to increase the issue of subsequent numbers to 3,000 owing to increased demand.

Questions of agricultural interest to Malays continually occur, where it is desirable to supply careful explanations of the reason for Government action; rubber restriction may be cited as a case in point. By the establishment of a direct link between the Agricultural Department and the Malay Public such as obtains through this publication, a ready means is at hand through which to disseminate knowledge, and to clear up misconceptions; a publication such as this should therefore have a political value not to be ignored.

For the present, Warta Perusahaan Tanah will be published quarterly. The second number now in the press includes articles on rubber restriction; the objects of the Sultan Idris College Tanjong Malim; the folly of importing goods that can be produced locally; Instructions for starting School Gardens; etc.

7. *The Sultan Idris Training College for Teachers, Tanjong Malim.*

This College was opened in November. The writer was appointed Acting Agricultural Instructor to the College in addition to his other duties. For purposes of giving instruction, he visits the College on Saturday and Sunday each week.

The instruction commenced at the beginning of December, there being 120 Malays taking a course of rural husbandry which is largely of a practical nature.

8. *Demonstration plots.*

Under the revised scheme of Agricultural Instruction, Demonstration plots are under the charge of the Inspection Division. The Instruction Division assisted in commencing the plots started by the Assistant Agricultural Inspector, Selangor at Batang Kali and Tanjong Malim, where roselle and kapok are planted.

9. *Penghulus.*

The Instruction Division strives to keep in close touch with penghulus. This is done partly by the publication of the Malay Bulletin and also by visits to the Mukims. A Meeting of penghulus of Kuala Selangor was held on October 21st at which various subjects, such as co-operation, cultivation of roselle, and kapok were discussed. A rather similar meeting was held at Bentong on October 30th attended by all the Penghulus of the District and by several Malay holders and towkays, there being about fifty persons present.

10. *Estate Visits.*

The Agricultural Instructor has paid 20 visits to estates during the year, either to offer advice or to acquaint himself more fully with particular points in agriculture.

11. *Publications.*

(*a*) Warta Perusahaan Tanah Vol. 1 No. 1 in November in the Malay language and Arabic character.

(*b*) "Kapok" articles in "Straight Times" July 8th 1922 and in Malayan Agricultural Journal Vol. 10 No. 2.

(*c*) "Wet Padi Planting in Negri Sembilan" Special Bulletin No. 33 of Department of Agriculture.

REPORT OF THE PLANT PHYSIOLOGIST FOR 1922.

By

W. N. C. Belgrave.

Staff.

Mr. W. N. C. Belgrave, Plant Physiologist, Haji Abdul Wahid, Junior Agricultural Assistant, and Incho Jalaludin, Malay Apprentice.

I desire to express my appreciation of the reliability of these two Malay Officers.

Work.

The time of the section has been almost entirely devoted to work on the rubber tree. The work may broadly be divided into field and laboratory work.

Field Work.

Records of individual tree yield have been taken on plots at the Government Plantations, Kuala Lumpur and Batu Tiga and on one estate. The records confirm previous observations that for short periods such as one year there are no significant alterations in order of merit of the trees of a plot, *i.e.* good yielders remain good and poor yielders poor. It is essential that this recording work should continue for a long term of years since improvement by selection ultimately depends on the unproved assumption that such constancy will be shown over prolonged periods.

"*Double V" Tapping.*—In view of what then appeared to be the possibility of serious labour shortage in the near future, experiments were started in May on the effect of tapping longer cuts at longer intervals of time than is usual. Two opposite V's girdling the tree were tapped at intervals ranging from 1 to 6 days. The yields from mature trees tapped every 5th day compared favourably with those obtained from the usual alternate day system, and so far no signs of injury have been noticed.

Although the fears of labour shortage appear to have been groundless, the experiments will be continued as several interesting points have emerged which demand further investigation.

"*Thinning Out.*"—Experiments on the effect of early and drastic thinning on subsequent growth and yield have been started.

I desire to express my thanks to those responsible for the direction and management of Estates on which permission has been given for the carrying out of field work.

Laboratory Work.

The main line of work selected for 1922 has been the study of those properties of latex which may be expected to influence flow and

yield. Among these are—viscosity, surface tension, osmotic pressure and acidity, (measured as hydrogenion concentration.) These properties have been studied individually and in their relation to each other, but up to the present it has not been found possible to formulate any general theory embracing the observed facts. Work will be continued. The chief difficulty encountered is that latex is a rapidly changing biological fluid, the condition of which at any moment is the result of the interplay of a number of internal factors.

State of Caoutchouc in Latex.—A study was made of the temperature changes in coagulation and of the co-efficient of expansion of latex compared with that of recently coagulated rubber. Both results suggest that caouthouc in latex exists in the solid state. Further work is required and will be undertaken.

Nitrogen in Latex.—Work has been started on the non-protein nitrogenous bodies, and a certain number have been isolated in a fair state of purity. Two may be mentioned, a lecithin-like substance and a substance with a strongly marked pyrrol reaction. The occurrence of the latter is suggestive in view of an attractive theoretical synthesis for caoutchouc through pyrrol bodies which has been put forward. Quantitative determinations are in progress.

Water Relationships.—Preliminary observations were made on transpiration and root pressure, but time was lacking for detailed work.

General Observations on Rubber.

The slump directed attention to the necessity of reducing costs in all possible directions, and the results of some of the attempts so to do will be of great interest physiologically.

Tapping Systems.—Daily tapping, once almost universal, has lost ground in favour of alternate day tapping over ½ and ⅓ the circumference. Many estates are experimenting with the "A, B" or "A, B, C" systems; the former involves daily tapping for 1½—2½ months followed by a like period of rest, the latter daily tapping for 1½—2½ months with double that period of rest. Time alone will show the advantages and disadvantages of each.

Bud-Grafting.—Great interest has been shown in work in progress in the Dutch Indies on bud-grafted rubber and some bud-grafting has been carried out locally. It is regrettable that hopes, or fears, of extraordinarily high yields are somewhat generally entertained together with some confusion between a demonstrated fact and an experiment. Even assuming the experiment to be a success, it is feared that some of the local work will be rendered useless by lack of sufficient care in selection of mother-trees.

Other Crops.

Nipah Palm.—Some preliminary observations were made on Nipah Palm but the subject does not yet seem to have become important enough to justify the expenditure of further time.

Publications.

No original work was published in 1922, none of the investigations undertaken having reached finality.

The following memoranda were prepared.

Opposite V tapping.

Early and drastic thinning out.

Seed selection.

Two articles were written for the "Hand-Book of Malayan Agriculture."

Reports received for publication 27th July, 1923.

COPY OF NOTIFICATION No. 4780 IN F.M.S. GOVERNMENT GAZETTE, dated 10th August 1923.

No. 16. Vol. XV. Page 1482.

"THE AGRICULTURAL PESTS ENACTMENT, 1913."

Agricultural Pests Supervising Committee.

No. 1780. Under the provisions of section 4 of "The Agricultural Pests Enactment, 1913" the following have been nominated by the Chief Secretary to Government to form, with the Secretary for Agriculture, Straits Settlements and Federated Malay States, as Chairman, the Agricultural Pests Supervising Committee.

The Legal Adviser ;

Mr. F. H. Mustard.

(G. 1297/23).

THE

Malayan Agricultural Journal.

Vol. XI. November, 1923. No. 11.

SOME FACTORS AFFECTING THE RATE OF VULCANIZATION OF PLANTATION RUBBER.

By R. O. Bishop.

Introduction.

As a result of the experimental work carried out by Eaton, Whitby, Stevens, De Vries and others it has been established that the optimum rate of vulcanization of plantation rubber is dependent upon the method by which the raw rubber is prepared from its parent latex: and within recognised limits the intrinsic vulcanizing properties of a piece of raw rubber can therefore be controlled by the producer.

The rubber which is produced at the present as plantation standard rubber may be divided into three groups according to the rate of vulcanization determined under standard conditions of a simple 9 ; 1 rubber sulphur mix. Thus 1st latex crepe has an optimum rate of vulcanization of approximately 3 hours, smoked sheet approximately 2½ hours, matured rubber or "slab" approximately 60 minutes.

It is not proposed to discuss whether these differences are of fundamental importance to the value of the rubber as judged by the manufacturer of vulcanized material or not, but, accepting the fact that the differences exist, it appears to be supremely important to obtain all the information which can be derived from a study of these differences in the rates of vulcanization of raw rubber.

Referring to work by previous investigators such as Whitby, Stevens, De Vries and Eaton it may be recalled that the most striking variations in rate of vulcanization of plantation rubber have been attributed to the incorporation with the caoutchouc of varying amounts of nitrogenous non-caoutchouc material which functions as an accelerator of the rubber sulphur combination.

Eaton, Day and Grantham[1] record work from which they infer that the nitrogenous accelerator exists in two forms or that there are two accelerators, one pre-formed in the latex, and of which a small proportion only is present normally in raw rubber prepared by

ordinary coagulation methods, while the other is formed from a non-caoutchouc protein material by decomposition brought about by certain organisms which are supposed to function under anaerobic conditions.

This latter accelerating substance appears to have received the most attention from investigators. It has been stated that the protein of the latex is decomposed into amino bodies during the maturation period and that sufficient of these bodies remain with the caoutchouc after washing and subsequent drying to cause acceleration.

The work of Stevens[2] carried out with the object of isolating such nitrogenous accelerators did not tend to confirm these views. Stevens extracted matured rubber with water for several days, precipitated the protein in the resulting solution by tannic acid, removed the tannic acid by barium hydroxide and then added phosphotungstic acid to the solution. By such means the phosphotungstate of a base was obtained, the total amount of the compound being approximately 0.03% on the original rubber. The base was not identified but it was assumed that the same substance could be isolated from serum.

Larger quantities were prepared from the serum (presumably "matured") which separated in the coagulating pans from 10 litres of latex, equivalent to 1,500 grms. rubber at the least. The amount was 0.59 grms. of accelerator which is significant in view of the fact that from a subsequent comparison of the accelerating properties of this substance with artificial accelerators it was concluded that the "base" isolated above was somewhat less powerful than p-nitrosodimethylaniline.

The latest contribution to our knowledge on the subject is contained in the work recently carried out by De Vries* who has drawn noteworthy comparisons between the rates of vulcanization of whole rubber and matured rubber. Certain details of the results recorded by De Vries are not in agreement with those to be reported here and it hoped that a statement of these differences will serve still further to illuminate the problem of latex composition and its influence on the vulcanizing properties of the derived rubber.

Experimental.

Alcohol Coagulation.—If fresh latex is dropped into 95% alcohol coagulation takes place instantaneously. The semi-granular coagulum can be collected without causing the granules to cohere, so that effective washing can afterwards be carried out. The washed mass can be filtered and partially dried on a Buchner funnel.

The coagulum can then be pressed in a hand-press and subsequently creped to a thin sheet which will dry completely in a few hours at the laboratory temperature. Should drying not be desired

* Archief voor de Rubbercultuur. August 1923.

the washed coagulum can be squeezed into a ball by hand and left for 7 days so that any "maturation" possible under the circumstances may take place.

By adopting this procedure some interesting differences were established in the rate of vulcanization of rubber precipitated from latex by alcohol. To illustrate these differences samples are described which were prepared in experiment 222.

A. 1000 c.c. of latex dropped into 3000 c.c. of alcohol which had been acidified by the addition of N/10 H_2SO_4 to adjust the pH value to 3. The temperature being that of the laboratory, viz: 25°—30°C throughout, and N/10 H_2SO_4 being added from time to time to maintain the pH value constant.

B. 1000 c.c. of the same latex dropped into 3000 c.c. of alcohol maintained at the same constant pH value (approximately 3), but the operation conducted at a temperature of 60°C.

C. 1000 c.c. of the same latex dropped into 3000 c.c. of alcohol of which the pH value was adjusted and maintained throughout at approximately 7. Temperature being about 25°C.

D. 1000 c.c. of the same latex dropped into 3000 c.c. of alcohol with pH value maintained at approximately 7 as for C above but having the temperature constant at 60°C.

E. 1000 c.c. of the same latex dropped into 3000 c.c. of alcohol of which the pH value was adjusted and maintained throughout at approximately 9. Temperature being 25°C.

F. 1000 c.c. of the same latex dropped into 3000 c.c. of alcohol as for E. above with pH value maintained at approximately 7 but having the temperature constant at 60°C.

The coagula obtained were washed and freed from adhering liquid. They were divided into equal portions —500 c.c. of latex providing one portion and the other 500 c.c. of latex providing the second portion. From each type of preparation one portion of coagulum was squeezed into a lump and kept 7 days, the other portion of coagulum was pressed into a sheet, creped, and dried within a few hours. After the lapse of 7 days the "matured" coagula were pressed, creped, and dried in a manner exactly similar to the corresponding portion previously creped.

The following table gives the results obtained by vulcanizing the rubber under uniform conditions in a 9 : 1 rubber sulphur mix.*

* For particulars of vulcanization refer Department of Agriculture Bulletin No. 27.

TABLE I.

Samples.	Temperature of coagulation.	pH of Alcohol. (approx.)	Optimum time of vulcanization of crepe. (minutes).	Optimum time of vulcanization of matured rubber. (minutes).
222 A.	25.°C.	3	150	135
222 B.	60.°C.	3	120	120
222 C.	25.°C.	7	150	135
222 D.	60.°C.	7	105	105
222 E.	25.°C.	9	105	70
222 F.	60.°C.	9	50	50

Matured slab rubber coagulated from the same latex in the standard manner by adding 3 ozs. of a 5% acetic acid solution to a gallon of latex, showed an optimum rate of vulcanization of 65 minutes.

Crepe rubber prepared in the standard manner by coagulating with acetic acid showed an optimum rate of vulcanization of 150 minutes.

From these figures the following facts appear :—

1. There is a striking progressive acceleration in vulcanization from samples A. B. to samples E. F.

2. The use of hot instead of cold alcohol for coagulation causes an accelerated rate of vulcanization of the rubber obtained.

3. The acceleration of vulcanization caused by the cold "alkaline" coagulation is equal to the acceleration of vulcanization caused by the hot neutral alcohol compared with the cold neutral alcohol. The latter is equal to the control.

4. The coagula derived from cold alcohol coagulations will, on keeping, develop an accelerated rate of vulcanization while no change occurs on keeping the coagula from hot alcohols.

Possible explanations of these facts may be enumerated as follows :—

A. Chemical. The added acid or alkali exerts an influence on the rubber by virtue of its intrinsic chemical properties.

B. Physical. The variations in hydrogen ion concentration of the latex owing to the added acid or alkali may cause physical changes which will result in alterations in the properties of the coagulated rubber.

C. The non-caoutchouc constituents may account for the variations in the rubber by their different solubilities in the "acid" and "alkaline" media.

D. There may be a combination of two or more of these explanations.

The possibilities will be examined under each heading.

A. It is relevant to record the amounts of acid and alkali which were used to produce the hydrogen ion concentrations in the three series of coagulations. In the "~~alkaline~~ acid" coagulations the quantity of H_2SO_4 used was approximately 0.06% by weight of the total weight of latex plus alcohol for coagulation. In the "alkaline" coagulations the quantity of NaOH used was approximately 0.07% by weight of the weight of latex and alcohol. These amounts are of the same order, and, for the acid within the limits prescribed for ordinary standard acid coagulation on a modern estate.

The following lines of action were adopted for further investigation :—

(i) A common stock of latex was coagulated as before by dropping into alcohol at 60°C. The hydrogen ion concentration of the alcohol being adjusted so that in one case pH was maintained at c3. and in another case at c9. A second "acid" coagulation and a second "alkaline" coagulation was then made with the same latex but the quantity of N/10 H_2SO_4 and N/10 Na OH added to the alcohol was doubled at each addition - the pH value of the alcohol being disregarded. By this means it was supposed that any absorption of mineral acid or alkali by the rubber during coagulation would be reflected in the optimum time of vulcanization of the dry crepe prepared from the coagula thrown down under extremes of "acid" and "alkali."

(ii) The samples of crepe prepared during the previous coagulations and under (a) above were to be examined for relative alkalinity or acidity of ash. For this purpose 5 grms. of the sample were ashed at the lowest possible temperature consistent with complete combustion of the carbon. The total ash was then digested with 100 c.c. water for 10 mins. and the pH value of the filtrate determined under uniform conditions.

In connection with this work it was fully realised that uncertainty must prevail as to the reactions occurring during the incineration of such a body as rubber, and the consequent combinations in which the mineral matter would appear in the final ash. Therefore it was felt that digesting the ash with water for a pH determination was open to criticism. And it was decided that no deductions could be drawn from negative results, although, it might be possible to establish sufficiently large relative differences between the "acid" and "alkaline" rubber ashes to indicate the lines for further investigation.

(iii) A third method adopted was the examination of the relative "acidity" of emulsions prepared from the dry crepe samples under constant conditions.

One gramme of the crepe was dissolved in 100 c.c. of benzene or petrol, and the solution kept in the dark for 4 days until homogenous. Five c.c. were then removed, shaken with an equal volume of alcohol and to the emulsion was then added 1 c.c. of water. The separated water was examined by the use of a range of indicators until the approximate pH was registered by comparison with a standard.

Table II gives the results obtained under the 3 methods (*a*) (*b*) and (*c*) above.

The figures show the inadequacy of the explanation that it is the chemical presence of the mineral acid or alkali which is the cause of the variation in the vulcanizing properties of the series of samples prepared in experiment 222 and previously described. They are also interesting as additional proofs of the natural variations which occur in latex.

Elimination of the obvious chemical explanation consequently forces one to consider the possible explanation based on physical grounds. It is apparent from an examination of the benzene emulsions, if reliance can be placed on the degree of difference indicated by the pH determinations, the a very small alteration in the pH value of a rubber will correspond to a considerable variation in rates of vulcanization.

TABLE II.

Rubber Ref. No.	Coagulant.	Optimum rate of vulcanization (minutes.)	Ash per cent.	pH Value of Ash extract approx.	pH Value of Benzene emulsion approx.	pH Value of Petrol emulsion approx.
222 K.	"Acid"	155	—	8	6	7
222 L.	Double "Acid"	150	0.36	8	6	7
222 M.	"Alkali"	75	0.29	7	7	8
222 N.	Double "Alkali"	75	0.19	9	7	8
222 O.	"Acid"	160	0.27	7	6	—
222 P.	"Alkali"	100	0.31	9	6	—
222 T.	Control Spontaneous coagulation*	105	0.37	10	6	—
234 HAH.	Special †	35	0.49	8	7	—
236 HAK.	Special †	10	0.30	8	—	—

* The sample 222 T. was a piece of crepe prepared from the coagulum obtained by allowing a quantity of the same stock to coagulate spontaneously without the addition of any coagulant and then maturing the coagulum for 7 days.

† These samples will be described fully on page 324. The results are inserted in this table for the purpose of comparing a rubber with an exceptionally rapid rate of vulcanisation obtained without an alkaline coagulant.

Experiment 235 was made to investigate the significance of small differences in hydrogen ion concentration of latex at the time of coagulation. In this experiment two series of coagulations were carried out on a common stock of latex. Four coagulations in the first series were designed to give samples of crepe, 235A—235D, from the same dilutions of latex, coagulated with a constant volume concentration of acetic acid, and necessarily under varying pH values. The four coagulations in the second series were designed to give samples of crepe, 235Ax—235Dx, from different dilutions of latex, with the additions of such proportions of acetic acid that the pH value of the latex at coagulation was constant, the constant value being the normal obtained when acetic acid is used as a coagulant under normal conditions. The coagula obtained at the end of 24 hours, were all washed, creped immediately and dried in a uniform manner. A description of the samples is summarised below :—

235A. Latex of 36% dry rubber content coagulated at pH 5.8 Coagulation was imperfect after 24 hours. The coagulum showed brown patches. The serum was milky and had a pH value of 4·4.

235B. Latex of 27% dry rubber content coagulated at pH 5.6 Coagulation less imperfect than A. The coagulum was pinkish. The serum was less milky than A. Serum pH 4.3.

235C. Latex of 15% dry rubber content coagulated at pH 5.4 Coagulation was perfect. The serum was colourless and clear and the coagulum was white. Serum pH 4.3.

235D. Latex of 10% dry rubber content coagulated at pH 5.2 Coagulation equally perfect with C. Serum pH 4.3.

235Ax. Latex of 36% dry rubber content coagulated at pH 5.4 Coagulation was imperfect after 24 hours. The coagulum showed brown patches. The serum was milky and had a pH value 4.3.

235Bx. Latex of 27% dry rubber content coagulated at pH 5.4 Coaguiation less imperfect than Ax. Coagulum pink. Serum milky, had a pH 4.3.

235Cx. Latex of 15% dry rubber content, coagulated at pH 5.4 Coagulation perfect, coagulum white, serum colourless and had pH 4.3.

235Dx. Latex 10% dry rubber content, coagulated at pH 5.4 Coagulation not so perfect as Cx.. Serum somewhat milky, pH 4.3.

The samples of crepe were vulcanized side by side under the usual conditions adopted throughout this work. The serum in each case was examined for total solids by pipetting out an aliquot portion

number of this Journal the separation by depolymerization of an insoluble portion will be is described. The material isolated from the following rubbers was examined for its influence on the vulcanization of normal crepe and "matured slab" crepe.

A. From rubber (represented by 222 K.L. above) derived from latex by "acid-alcohol" precipitation. Optimum rate of vulcanization 2½ hours.

B. From rubber (represented by 222 M.N. above) derived from latex by "alkaline--alcohol" precipitation. Optimum rate of vulcanisation 75 minutes.

C. From a normal standard 1st latex crepe. Acid coagulation of latex according to standard estate practice. Optimum rate of vulcanization 2¾ hours.

D. From a matured slab rubber crepe.* Optimum rate of vulcanization 60 minutes.

Equal weights of these materials were machined with the rubber when making up mixes for 9 : 1 rubber sulphur vulcanizations. The "compounds" were then vulcanized side by with a control containing no added material. The results are given in Table VI.

TABLE VI.

Sample Ref. No.	Amount of Nitrogenous Insoluble Matter added to rubber.	Optimum time of Vulcanization (minutes).
287 Fc.	0.5% A.	180
287 Gc.	0.5% B.	180
287 Ac.	0.5% C.	180
287 Kc.	0.5% D.	180
287 Lc.	Nil. Control	180
287 Ms.	0.5% A.	60
287 Ns.	0.5% B.	60
287 Os.	0.5% C.	60
287 Ps.	0.5% D.	60
287 Rs.	Nil. Control	60

From which it appears that the nitrogenous insoluble matter isolated from raw rubber by depolymerization of an ordinary raw rubber does not possess accelerating properties when added to a 9 : 1 rubber-sulphur mix.

It may be argued here that the addition of nitrogenous residues to crepe is not the correct way to demonstrate their true effect on the vulcanization of rubber and sulphur. But in justification of the acceptance of deductions from the above results it must be borne in mind that the work is strictly comparative and it appeared reasonable to suppose that the parent rubber exhibited such marked differences on vulcanization that the derived insoluble products A.B.C.D. might be expected to reflect these differences when incorporated with a neutral rubber for vulcanization.

* For details of preparation see F.M.S. Bulletin No. 27, Eaton & Co-workers.

That the results are not in agreement with those published by Beadle and Stephens[3] or by Spence and Kratz[4] may be accounted for by the fact that in their work the effect of the insoluble matter was tried on the parent rubber and as evidence of the unsuitability of such a base for comparative trials the author desires to call attention to the influence of added starch and again litharge, a matter which will be referred to later in this article.

In order to gain further information on the accelerating effect of individual bodies contained in the residual serum of acid coagulated latex a separate investigation was conducted. The chemical aspects of that investigation will be described in the next number of this Journal, it remains to record here the vulcanization results obtained.

In experiment 263 air-dried naturally evaporated serum solids were added to fast and slow curing rubber from the same latex. A stock of latex was coagulated with acid and the coagulum drained from adherent serum liquor and divided into two portions; one of which was creped immediately and washed while the other was matured for 7 days before crepeing and washing.

The serum liquor was spread in a very thin layer in enamelled pans and allowed to dry in the air. After six weeks the liquor had dried to a black sticky substance which was collected and dried further in a vacuum desiccator. When suitable for weighing and mixing definite known weights of the serum solids were incorporated with the dry original rubber for vulcanization in a 9:1 rubber sulphur mix.

The following are typical of the results obtained :—

TABLE VII.

Sample.	Amount of substance added.	Optimum time of vulcanization (Minutes).
Original rubber Crepe	Nil	195
Crepe plus	1.25% serum solids	90
Original matured Crepe	Nil	95
Matured slab crepe plus	1.25 serum solids	75

In experiments 205 and 282 the effect was tried of the addition of various "individual" substances which had been isolated and examined as described in the forthcoming article on "Certain constituents of latex". It was found that the following bodies were without effect. Heat coagulable protein, magnesium pyrrol body coagulated by alcohol from serum, lecithin body, acetone soluble waxy substance.

In experiment 286 comparisons were made between the vulcanizing properties of ordinary crepe, matured slab crepe, the rubber substance obtained from spontaneously coagulated and evaporated latex (i.e. the rubber substance containing all serum solids), and the same rubbers to which extra serum solids* had been added prior to vulcanization.

* Prepared as already described under experiment 263.

The following table shows the results obtained :—

TABLE VIII.

Sample.	Description.	% Added Serum substance.	Optimum time of vulcanization (minutes).
286 Ac.	Ordinary Crepe	Nil	160
286 Asm.	Matured slab crepe	Nil	60
286 Aw.	Whole rubber by evaporation.	Nil	40
286 AcN.	Ordinary Crepe	2%	90
286 Asm.N.	Slab Crepe	2%	60
286 AWN.	Whole rubber by evaporation	2%	40

In experiment 296 an attempt was made to produce a rapidly vulcanizing rubber by the incorporation of serum solids which had been made to undergo decomposition. Serum derived from acid coagulated latex was first heated and the heat coagulable protein substance thus isolated, the residual liquor was then evaporated on a steam bath to a viscous brown syrup. These separate bodies were added to fresh water in the proportion of 10 grams per 100 cc. and set to decompose under aerobic conditions and under anaerobic conditions by inoculating with fresh latex. The contents of the dishes and tubes after 14 days were were made up to the original volume and were spotted on to pieces of a slow curing crepe rubber which were dried and then mixed with sulphur for vulcanization as usual, with the following results: —

TABLE IX.

Sample.	Description.	% Amount of material added to rubber plus sulphur.	Optimum time of vulcanization (minutes).
296 Ac.	Original protein substance	1.0%	135
,, Bc.	Undecomposed residue of serum solids	1.0%	135
,, Cc.	Protein decomposed aerobic	1.0%	135
,, Dc.	Serum residue decomposed aerobic	1.0%	120
,, Ec.	Protein decomposed anaerobic	1.0%	125
,, Fc.	Serum residue decomposed anaerobic	1.0%	135
,, Gc.	Control Crepe	Nothing added.	165
,, Hc.	Diphenyl guanidine.	1.0%	15
,, BcR.	Similar to Bc.	2.0%	120
,, DcR.	Similar to Dc.	2.0%	90
,, FcR.	Similar to Fc.	2.0%	135

Experiment 299 shows the comparative results of vulcanizations made on ordinary crepe and matured slab crepe with the addition of decomposed serum solids unseparated and decomposed protein substance and decomposed "non-protein residue." A common stock of latex coagulated with acetic acid in the ordinary manner and the coagulum freed from adhering serum liquor, was divided into two portions one

of which was machined at once and washed thoroughly and the other matured for 7 days before machining and washing.

The serum liquor was divided into two portions X and Y. Y was treated thus—protein substance precipitated by warming to 60°C and maintaining until no further precipitate was obtained. The washed precipitate Yp was transferred to fresh water to which had been added 2 or 3 drops of latex and then allowed to decompose in very shallow layers in large open pans in which the surface of the liquid was freely exposed to the air. The residual liquor after the separation of the protein was evaporated as completely as possible on a steam bath. This substance called for convenience "serum residue" and labelled Ys was then added to latex inoculated water in the same proportion as Yp above and allowed to decompose under identical conditions.

The portion of serum liquor X was spread in a film approximately 0.5 m m. thick on large glass plates which were set aside in the laboratory and protected from dust but to which air was allowed free access. Drying did not proceed to completion owing to the deliquescent nature of the serum solids, consequently after 7 days the required amount of material was added to the original dry raw rubber by rubbing a known weight of the rubber over the glass plates and reweighing the rubber at very short intervals until the required gain in weight due to adherent serum solids had been obtained.* The rubber plus serum solids was then sprinkled with the requisite weight of sulphur (1/9 weight of the dry rubber) and the whole was machined and mixed without any difficulty.

TABLE X.

Sample Ref. No.	Description.	Amount of material added % on the dry rubber.	Optimum time of vulcanization Minutes.
299Ac.	Standard crepe† machined at once.	Nil	135
299As.	Matured slab crepe machined after 7 days.	Nil	60
299AcX.	Crepe Ac. plus decomposed serum solids X.	3.0%	65
299AsX.	Matured crepe As. plus decomposed serum solids X.	3.0%	40
299AcYp.	Crepe Ac. plus decomposition products from protein substance Yp.	3.0%	90
299AsYp.	Matured crepe As. plus decomposition products from protein substance Yp.	3.0%	45
299AcYs.	Crepe Ac. plus decomposition products from Residue Ys.	3.0%	100
299AsYs.	Matured crepe As. plus decomposition products from residue Ys.	3.0%	60

* By proceeding slowly it was found an easy matter to make additions in a uniform manner and weighings were possible to 0.01 gramme.

† The latex used was strong consequently this crepe from an undiluted latex is not strictly "standard."

Consideration of the results recorded above, and many confirmatory tests which it is impossible on account of space to give here, leads to several conclusions, some of which have been recorded by previous investigators. For convenience they are tabulated here.

(a) Aerobic decomposition produces a more effective accelerating agent than anaerobic decomposition of protein substance or serum residue.

(b) The addition to raw rubber of serum solids or their decomposition products causes an accelerated vulcanization up to a point. However, it does not appear from these investigations that the rate of vulcanization can be accelerated beyond a well defined maximum by the addition of even large quantities of "natural" accelerators.

(c) The acceleration of vulcanization effected by the addition of a typical *artificial* organic accelerator, known also as a protein decomposition product, is very much greater than any acceleration observed for the addition of serum decomposition products.

(d) Rubber with the most extreme *naturally* accelerated vulcanization properties so far known is that produced by the intimate association of all the non-caoutchouc bodies of latex with the caoutchouc in evaported whole rubber.

In consequence of which, further work falls naturally into the following lines of investigation.

(i) Whether the accelerated vulcanizing properties of matured slab rubber can be reduced in any degree by continued washing of the rubber ?

(ii) The examination of differences between anaerobic and aerobic production of matured slab rubber.

(iii) Whether by increasing the proportion of non-nitrogenous substances in raw rubber the time of cure of matured slab rubber can be further reduced ?

(iv) The effect of evaporating latex under different conditions on the properties of the resulting whole rubber substance.

(i) The results obtained in this direction may be gathered from the following typical experiment.

A large piece of matured slab rubber* was cut into four portions and treated thus :—

A. Control portion machined 9 times to reduce the lump to crepe.†

Machine	1.	Three times.
,,	2.	do.
,,	3.	Twice.
,,	4.	Once.

* Dry coagulum. Grey on exterior and quite dry to handle but having a white interior containing 20% moisture.

† 4 machines were used.

The rolls of the machines were graded.

Machine 1.	having rolls set ¼" apart.		
,, 2.	do.	1/8" apart.	
,, 3.	do.	1/24" apart.	
,, 4.	rolls set close for smooth crepeing.		

Copious washing was given on each machine.

B. Portion machined 12 times viz.

Machine 1.	three times.
,, 2.	do.
,, 3.	do.
,, 4.	do.

C. Portion machined 18 times as for B with additional 6 times in machine 4.

D. Portion machined 24 times as for C with additional 3 times in machine 3 and 3 times in machine 4.

E. Portion machined 36 times as for D with additional 6 times in machine 4.

F. Portion machined 3 times in No. 1 machine then soaked for 24 hours in water with a change of water at the 12th hour.

G. Portion machined twice in No. 1 machine and then soaked in water as for F.

H. Portion machined 3 times in No. 2 machine and then soaked in water as for F and G.

Extensive washing on each of the machines took place throughout the operations.

The creped rubber was then dried. mixed with sulphur and vulcanized.

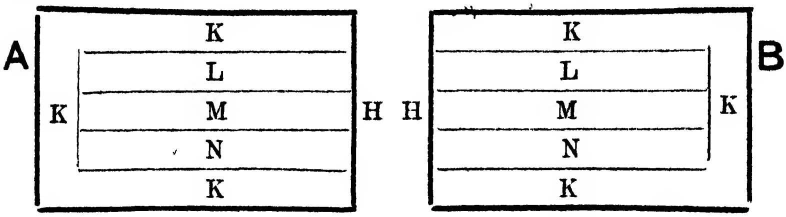
It was found that the optimum time of vulcanization—60 minutes was absolutely identical for all the samples A to H and the stress-strain curves of the vulcanized samples coincided for all times of cure proving absolutely that the rate of vulcanization of a raw rubber cannot be influenced by washing or machining and therefore that the accelerating agents are not removable by solution with water or by mechanical means.

(ii) The examination of crepe derived from different sections of a matured slab provides interesting observations on the enhanced vulcanizing properties of that type of rubber.

A bulk of latex was coagulated without the addition of acid, i.e. spontaneously, to form a large lump of coagulum. This was raised from the serum liquor, drained and divided into two portions A and B. These portions were allowed to mature on open racks in the air and were turned every alternate day. While the rubber was maturing the surface of A was kept absolutely free from the stinking alkaline slime

which normally forms, by rubbing over with a damp clean cloth every 24 hours. The surface of B was allowed to remain untouched, and the dirty slime developed in a normal manner.

The diagram shows how portions A and B were cut into sections. The rubber from each section in A was creped and washed very thoroughly while the rubber from B was creped uniformly with A but was not washed.



The results of one experiment are given in detail :—

TABLE XI.

Sample Ref. No.	Description of Sample.	Optimum time of vulcanization (minutes).
234 AH.	Outside section from clean slab	40
„ BH.	„ „ dirty slab	40
„ AK.	Exterior layer from clean slab	45
„ BK.	„ „ clean slab	45
„ AL.	Section L from clean slab	60
„ BL.	„ „ dirty slab	60
„ AM.	Section M from clean slab	60
„ BM.	„ „ dirty slab	60
„ AN.	Section N from clean slab	60
„ BN.	„ „ dirty slab	60

In a further experiment the mature rubber was derived from coagulum which had been obtained from *acid* coagulated latex. A large bulk of latex was coagulated with acetic acid according to standard estate practice and the coagulum obtained was divided into two portions and treated exactly the same as described under the previous experiment.

The results of vulcanizing the crepe samples are given :

TABLE XII.

Sample Ref. No.	Description of Sample.	Optimum time of vulcanization (minutes.)
236 AH.	Outside section of clean slab	40
„ BH.	„ dirty slab	40
„ AK.	Exterior layer from clean slab	40
„ BK.	„ dirty slab	40
„ AL.	Section L from clean slab	60
„ BL.	„ „ dirty slab	60
„ AM.	Section M from clean slab	60
„ BM.	„ M from dirty slab	60
„ AN.	„ N from clean slab	60
„ BN.	„ N from dirty slab	60

In a further experiment using latex containing less dry rubber per unit volume than that used for experiments 234 and 236 the coagulum derived by acid coagulation was matured complete in one piece. The matured slab was then divided into an exterior layer approx ¼" thick and an internal section, while a portion of the entire slab was kept intact. The three samples were then creped uniformly and the creped samples vulcanized.

TABLE XIII.

Sample Ref. No.	Description of sample.*	Optimum time of vulcanization (minutes.)
309 A.	Whole matured slab creped and washed.	45
309 B.	Exterior section creped and washed	20
309 C.	Interior section creped and washed	50
309 D.	Exterior section creped without any washing.	20
309 E.	Interior section creped without any washing.	15

The results recorded above, and many others, show that the exterior of matured rubber slabs possesses very different vulcanizing properties from the interior.

There are two possible explanations for this; firstly that the exterior contains a larger proportion of non-caoutchouc substances owing to surface exudation and evaporation, secondly that that the surface being in contact with the atmosphere is affected differently from the interior which is not in contact with the atmosphere. A chemical examination of the interior and exterior rubber does not indicate the presence in the rubber of an increased proportion of non-caoutchouc substances. The ash, the acetone extract and the Kjeldahl nitrogen are all within the normal limits for that type of rubber, and present technique does not allow the establishment of any significant differences. Again there is the direct evidence of experiment 234 and 236 in which comparisons were made between the rates of vulcanization of (B) slabrubber with which was incorporated all the slimy surface decomposition products and (A) slab rubber which was as far as possible deprived of the slimy surface decomposition products The uniformity of the rates of vulcanization may be taken as additional proof of the correctness of the second explanation.

(iii) At this stage it is well to consider some results which were obtained by carrying investigations along the third line indicated above: to see if (and to what extent) an increased proportion of non-caoutchouc bodies, (nitrogenous and non-nitrogenous), would influence

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* Practical assistance in the preparation of certain samples has been given by Mr. Hooper of the F.M.S. Rubber Co. to whom thanks are due.

the vulcanizing properties of the matured rubber substance. One method of increasing non-caoutchouc bodies is to make an extract from one bulk of raw rubber and add the extract to a new bulk of rubber or replace the extract in fresh proportions.

A considerable volume of work has been done in that manner and in the case of the acetone extract there exists already a mass of published results to which reference can be made [5, 6]. In the present instance the results will be given of vulcanizations which were carried out on matured rubber, in which the non-caoutchouc constitutents had been increased by fractional coagulation of the original latex.

It has been established by repeated observation and recorded by many observers that a bulk of latex can be coagulated in such a manner that the rubber produced from the coagulum first formed differs from the rubber produced in later stages of coagulation.[7] The ash, acetone extract, and total N_2 (by Kjeldahl estimation) are all higher in the first coagulum than in rubber normally prepared. In one experiment, 40 gallons of undiluted latex* were treated with half the usual quantity of acetic acid. Three gallons were removed (E) set aside, and allowed to coagulate without further treatment. The remainder coagulated slowly with continuous stirring. After 30 mins. from the addition of the acid a small quantity of coagulum (A) was removed from the bulk of the otherwise completely liquid latex. Stirring was continued for a further 30 mins. and another small quantity of coagulum (B) was removed. Stirring and the subsequent removeal of coagulum at intervals of 30 mins. was proceeded with for sample (C) and (D) after which it was found that partial coagulation was not yielding quantities of coagulum suitable for subsequent treatment. An additional volume of acetic acid was added to the latex making the total quantity approximately equal to that normally employed† in latex containing 15% D.R.C. and the whole then allowed to coagulate. This coagulum (F) was obtained at the expiration of a further 90 minutes.

The fresh coagula A...B...F. were then divided into two portions Ac. Bc. Cc....Fc. which were washed thoroughly, creped and dried within 24 hours and portions As. Bs. Cs. Ds. Es. Fs. which were balled roughly to pieces of equal superficial area and set aside in the open air for 7 days to mature. Each matured slab was then cut into two sections, K, a layer cut as thin as possible from the interior of the slab, and M, the remainder, composing the interior of the slab. These sections were creped and washed very thoroughly in a uniform manner and the rubber was dried within 24 hours as for the samples creped previously.

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* Containing 40% D.R.C. i.e. 4 lbs. dry rubber per 1 gallon acetic acid coagulated latex.

† Normal coagulant is 3 ozs. of 5% acetic acid per 1 gallon of latex.

The results of comparative vulcanization are tabulated.

TABLE XIV.

Sample Ref. No.	Description.	Optimum time of vulcanization (Minutes.)	Optimum time of vulcanization of the dry crepe after extraction with cold acetone* (Minutes.)
267 Ac.	First fraction creped immediately.	165	135
„ Be.	Second fraction creped immediately.	165	135
„ Ce.	Third fraction creped immediately.	165	135
„ De	Fourth fraction creped immediately.	165	135
„ Ee.	Original bulk sample creped immediately.	210	180
„ Fe.	Residual latex bulk creped immediately.	210	180
„ ASK.	First fraction matured exterior creped	40	65
„ BSK.	Second fraction matured exterior creped.	40	65
„ CSK.	Third fraction matured exterior creped.	40	65
„ DSK.	Fourth fraction matured exterior creped.	40	65
„ ESK.	Original bulk sample matured exterior creped	55	75
„ FSK.	Residual latex matured exterior creped.	50	80
„ ASM.	First fraction matured interior creped.	40	75
„ BSM.	Second fraction matured interior creped.	40	75
„ CSM.	Third fraction matured interior creped.	40	75
„ DSM.	Fourth fraction matured interior creped.	40	75
„ ESM.	Original bulk sample matured interior creped.	90	95
„ FSM.	Residual latex matured interior creped.	90	95

The losses on extraction recorded, are particularly interesting for the matured rubber.

* These results are inserted here for convenience of comparison. The dry rubber crepe was extracted with cold, freshly redistilled, acetone in glass bottles in the dark for 10 days. The acetone was replaced every 24 hours. At the expiration of the 10 days the rubber was dried in a warm atmosphere – 30°C, and weighed.

TABLE XV.

Sample.	Loss % by cold acetone extraction.	Sample.	Loss % by cold acetone extraction.
ASM. interior	3.0	ASK. exterior	1.8
BSM. do.	3.2	BSK. do.	1.3
CSM. do.	2.9	CSK. do.	1.8
DSM. do.	2.2	DSK. do.	1.9
ESM. do.	1.8	ESK. do.	1.5
FSM. do.	1.2	FSK. do.	1.8

The "acetone extracts" estimated by extraction with hot acetone in a glass Soxhlet extraction apparatus for 15 hours, drying and weighing the extract, were as follows:

Ac. 1st Fraction	Acetone	extract %	on dry rubber	...	2.2
Bc. 2nd	do.	do.	do.	...	2.1
Cc. 3rd	do.	do.	do.	...	2.5
Dc. 4th	do.	do.	do.	...	2.6
Ec. Original		do.	do.	...	1.8
Fc. Final residue		do.	do.	...	1.5

From these results and others published it appears that the fractions, which contain the larger proportion of extractive matter, vulcanize more rapidly than the whole rubber or the residual rubber obtained from latex after the removal of those fractions; and maturation of the coagulum leads to an enhanced accelerated vulcanization for those coagula containing the larger proportion of non-caoutchouc bodies.

Further consideration of the comparative results for the rates of vulcanization of the dry creped from the interior and exterior sections of the matured slabs leads to the following conclusions:—

(a) The exterior of a matured slab from partially coagulated latex does not show a faster rate of vulcanization than the interior—though the bulk latex and residual latex do show considerable differences between the exterior and interior as previously recorded in experiments to 234 and 236.

(b) The differences in rates of vulcanization between the exterior sections of the fractions and the bulk latex coagula (after maturation) are comparatively small compared to the differences in rates of vulcanization displayed by the corresponding interior sections of the matured coagula and the large differences between the corresponding coagula creped before maturation.

(c) Extraction with cold acetone leads to a corresponding accelerated rate of vulcanization for all the samples Ac. - Fc. but not so for the same coagula after maturation. Extraction of the matured dry rubber leads to a slower vulcanization for all the samples, though the retardation is practically negligible for the samples Esm.

and Fsm. and a pronounced difference appears between the rates of vulcanization of the exterior and interior of the partially coagulated slabs.

The striking fact is that these alterations in rates of vulcanization do not appear to be related to the losses in weight of the raw rubbers nor can they be accounted for by the values for the acetone extracts of the crepe samples.

An examination of the extracts obtained by the cold extractions has not led to the conclusion that the extracts from samples Ac.—Fc. contain accelerating substances but the reverse, and it has already been stated that two separate substances isolated from latex as acetone soluble bodies are without influence on the rate of vulcanization of raw rubber. On the other hand the results of earlier work by Beadle and Stevens Van Heurn, and recently by Stevens[10] tends to lead to the conclusion that acetone extraction may not always produce uniform alterations even with a uniform type of rubber. It is significant that Stevens has recorded as a result of his later work, the conclusion that "the correlation between the amount of acetone extract and rate of vulcanization is not directly connected with the presence of putrefaction bases, as acetone extraction which should remove the bases may result in a more rapid vulcanizing rubber."

The work detailed in this section again serves to show that the increase of water soluble non-caoutchouc constituents or their putrefactive decomposition products does not entirely account for the accelerated rate of vulcanization of matured rubber, whereas the difference between the exterior and interior of slab rubber is highly significant of a factor in maturation which has hitherto been unconsidered.

(iv) *The rate of vulcanization of whole rubber.*—Leaving further discussion of the results recorded above and their bearing on established views, it is necessary to refer back to the fourth line of investigation mentioned earlier.

An investigation of the vulcanizing properties of the whole rubber produced by evaporating latex under different conditions was carried out. Unfortunately, circumstances have precluded the possibility of examining more than the merest fringe of the problem but enough has been achieved to lead the writer to the conclusion that the results are significant and they appear to be relevant to the present issue.

Latex, undiluted, and treated with the minimum delay after flowing from the tree may be evaporated to a uniform transparent film of rubber material which on testing under the standard conditions exhibits a comparatively rapid rate of vulcanization in a 9 : 1 rubber sulphur mix, being normally about 60 minutes, which is practically the same as that for matured slab rubber under the same conditions. There can however be no question of the development of *putrefactive* bases in the evaporated whole rubber because the time elapsing from tapping the latex to vulcanization of the rubber has on several occasions been no longer than 3 hours and an examination of the latex and the derived rubber has been controlled by bacteriological examinations which practically precluded the possibility of putrefactive changes.

The rate of vulcanization of this evaporated whole rubber shows some striking variations on certain days, although control samples of acid coagulated creped and matured slab rubber from the same latex does not reflect these variations; it does not appear possible at the moment to correlate the variations to differences in the chemical constants of the latex examined It is necessary to add in this connection that the work so far carried out has not been more than superficial and it will be obvious to investigators familiar with the normal daily variations in latex that any results must be recorded over a long period before they can be interpreted.

Apart from these variations which may for the present be regarded as inherent to the latex there are variations, in the vulcanizing properties of the whole rubber, which are due to external influences during preparation of the rubber substance.

These may be illustrated by quoting the results of actual experiments.

TABLE XVI.

Sample Ref. No.	Description of Method of Preparation.	Optimum time of vulcanization (minutes).
305 X.	Latex spread on glass plates. Drying complete in 20 mins. at 45°C* in drying chamber.	60
305 Y.	Same latex transferred to dark room on collection spread on glass plate in dark room under a fan. Drying complete in 3 hours at 25°C.	120
305 X.	Same latex spread on glass plates in laboratory in bright diffuse light. Drying complete in 3 hours at 30°C. Rubber film allowed to remain exposed for 24 hours before mixing with sulphur.	120
305 Ac.	Same latex coagulated with acid, coagulum raised and creped and the crepe dried in the ordinary manner.	150
305 W.	Same latex through which air had been blown for 60 minutes; then coagulated with acid, coagulum raised, creped and the crepe dried in the ordinary manner.	150
305 AS.	Same latex coagulated, coagulum raised and matured for 7 days, then creped etc. as for 305Ac.	•
306 A.	Latex spread on glass plate in hot chamber Drying complete in 15 minutes at 45°C.	70
306 B.	Same latex spread on glass plates in dark room under fan. Drying complete in 3 hours at 25°C.	120

* The glass plates 92cms. x 23cms. area were used as shelves in a drying chamber: 25ccs. of latex were spread on each plate. The interior of the chamber was heated by steam pipes at the bottom and the air circulated by a suction fan in the top. Temperature was controlled by a thermometer projecting into the centre of the chamber.

Sample Ref. No.	Description of Method of Preparation.	Optimum vulcanization time of (minutes).
306 C.	Same latex spread on glass plates in laboratory under fan. Drying complete in 2 hours.	120
306 D.	Same latex treated exactly as 306A. but kept in hot chamber for a further 24 hours.	90
306 E.	Latex spread on glass plates in hot chamber. Drying complete in 15 minutes at 45°C.	90
306 F.	Same latex spread on glass plates in dark room under fan. Drying complete in 3 hours. Mixing of rubber with sulphur after 24 hours.	120
306 G.	Same latex spread on glass plates under dark room exactly as 306F. above but maintained in dark room for a further 48 hours.	240

A very marked difference in appearance is found to exist between the rubber prepared by evaporating latex in the warm chamber and that prepared by slower evaporation in the laboratory and the dark room. The former rubber 305X., 306A., 306E. and other samples not mentioned here are absolutely transparent, almost colourless, and possessed of a good elasticity in the raw state. The latter rubber 305Y., 306F., 306G , etc. are opaque samples giving a brown rubber lump and is almost devoid of elasticity in the raw state.

The tensile strength of all the samples after vulcanization was normal and did not exhibit any material differences.

These results taken in conjunction with those published by previous investigators[6] on evaporated latex are, in the writer's opinion significant.

It has been established by the work of Weber, Herbst, Peachey and others that caoutchouc forms a definite series of oxidation products and that these appear to be additive compounds of the type $_{0}H_{16})_{x}O_{N}$. Further investigations have shown that the oxidation of caoutchouc is an autoxidation and the curves connecting oxygen absorption with time, obtained by Peachey, are characteristic of an autocatalytic process[11]. This view further developed by Kirchof suggests the formation of an unstable peroxide as an intermediary in the oxidation of caoutchouc.

If such views are considered in conjunction with the results of certain work by Kerbosch[12] on the susceptibility to oxidation of certain samples of rubber, before and after removal of the latex serum substances, and under the influence of added albumin it will be seen that the method of preparation of rubber may lead to important variations in the composition of the material, which will be unconnected with putrefactive changes.

This article has been written with the object of demonstrating what appears to the author to be a significant connection between the oxidation of caoutchouc and the rate of vulcanization of raw rubber.

There has been little doubt on the part of others that the nitrogenous constituents of the non-caoutchouc substances accounted for a part only of the vulcanization properties of raw rubber[10]. The present work justifies and confirms those views and in addition brings out results which seem to prove the importance of oxygen in contact with the caoutchouc itself.

The presence of a peroxidase in Hevea latex has been recorded[12] and it has been understood that the enzyme is brought down with the rubber when latex is coagulated. The extraction of a peroxidase from the surface of "Fine Hard Para" rubber was recorded by Spence over fourteen years ago. The distinctive colour of the fractions obtained in the partial coagulation of latex by acid has been attributed to the increased quantity of an unknown yellow body which is connected with the presence of oxidation products and an oxydase.

The facts recorded under experiments 234, 236 and 309 in which the exterior of a matured slab was shown to possess more rapid vulcanizing properties than the interior of a matured slab, the fact that the rate of vulcanization is not affected by washing with water, and also the facts recorded under experiment 267 appear to justify the conclusion that the rate of vulcanization of raw rubber is largely influenced by the presence in the rubber substance of caoutchouc oxidation products which may be first formed through the agency of a peroxidase in latex.

It is suggested that the initial stage in the oxidation whether through a peroxidase or an autocatalytic process gives rise to the formation of a labile peroxide, similar to that formed from terpene substances and studied more particularly in the case of oil of turpentin. The presence of the labile peroxide will in an atmosphere of sulphur vapour cause accelerated vulcanization but in an atmosphere of oxygen, or, in air further oxidation takes place with the formation of oxygen saturation products of caoutchouc. These are the natural products of ageing of raw rubber and consequently the rate of vulcanization of aged sample will differ materially from the originals.

In some cases ageing may lead to an acceleration of vulcanization owing to the formation of peroxide, but in other cases in which the maximum proportion of peroxide has been formed and the original sample was a rapid vulcanizing rubber, ageing will cause a retardation.

There is so far no definite proof of the enhanced vulcanizing properties of caoutchouc at certain stages of oxidation and work in that direction is be set with difficulties which will only be overcome slowly, but an opening has been made on the examination of films of latex-evaporated rubber and their properties after vulcanization by a cold process. In a subsequent publication it is proposed to give a description of the apparatus and method of work and a resume of the initial results.

In conclusion the author desires to acknowledge his indebtedness to the help which has been given by Mr. W. N. C. Belgrave, Plant Physiologist and to record the fact that the entire work has been carried on as a result of discussion with him.

SUMMARY.

The coagulation of latex by dropping into alcohol of variable hydrogen ion concentrations produces samples of rubber which exhibit significant variation variations ir rate of vulcanization.

These variations are not accounted for by simple chemical or physical explanations based on previously accepted views regarding the variations occuring in raw rubber.

Attempts to account for the facts observed and considerations of the properties of depolymerized rubber residues, various serum substances and their decomposition products, gives rise to the supposition that it is the caoutchouc of raw rubber which is most intimately concerned in the changes taking place when coagulum is "matured."

Consideration of the important differences in "maturation" brought about by the air and the effect of acetone extractions leads to the further supposition that the caoutchouc forms oxidation products which exert a profound effect on its vulcanization properties.*

Previous work on the oxidation of films of rubber and the author's present results on the vulcanization of latex evaporated rubber tend to confirm these suppositions and it is suggested that the ageing of raw rubber is a natural sequence of "maturation" and its effects.

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Received for publication 15th October, 1923.

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* The presence of a peroxidase in latex and its possible effect on a wet coagulum may account for the differences observed between the mature rubber from hot and cold alcohol-coagulated latex.

PRELIMINARY REPORT ON THE DISTRIBUTION BY THE INSPECTION DIVISION IN PERAK NORTH OF SELECTED PURE STRAINS OF PADI.

By F. Birkinshaw.

As the result of the work of several years by the Economic Botany Division there are in existance at the Titi Serong Rice Experiment Station isolated pure strains of padi capable of producing higher yields than the unselected varieties of the country. The aim now is to get these high yielding pure strains generally known and grown by cultivators and the following is an account of the results achieved in this direction during the past two seasons by the Inspection Division in Perak North. This division of the State comprises the Districts of Krian, Larut (including the sub-districts of Matang and Selama) Kuala Kangsar and Upper Perak.

Reasons why proper control of distribution is necessary.

The introduction of improved strains of padi to Malay cultivators is not such a simple matter as it may appear to be at first sight. The despatch of a quantity of selected pure line seed to a number of centres for distribution to cultivators would be no guarantee of improved yields throughout the country for the following reasons :—

Firstly. The cultivator's prejudice in favour of local varieties which he has habitually grown. In each locality the Malay cultivators have a strong predilection for the varieties of padi which have been grown in the locality for a number of years. This partiality is justified to a large extent, for it is certainly true that the varieties grown in a particular locality are amongst those most suited to local conditions of soil, irrigation and methods of cultivation. The result of an uncontrolled broad-cast distribution would, therefore, be either that the distributed seed would be used for food, or, if sown, would be planted on a small portion of the worst land in the locality concerned, the best land being reserved for the local varieties in which the cultivators place their faith. Under such conditions the selected pure strain would probably give a lower yield than the local varieties. The cultivator would have proved to his own satisfaction the superiority of his local varieties and thereafter would refuse to plant any other.

Secondly. The necessity to select for distribution a strain of a variety suitable for its intended environment. From this standpoint it may be pointed out that conditions vary, not only in different parts of a District but also in different fields in a locality and sometimes even in different portions of a field itself. Less efficient irrigation on one portion of a field as compared with other portions may make it advisable to distribute two dissimilar varieties or strains for the same field.

Thirdly. The necessity to guard against the deterioration of pure strains through admixture with unselected seed.

Fourthly. The importance of determining and recording comparative yields between distributed strains and local varieties. This not only helps to determine the suitability for its environment of the pure strain, but also may suggest the advisability of attempting the isolation of a high yielding pure strain from one or more of the local varieties.

Fifthly. The necessity of provision for making comparative tests of pure strains in a number of localities in order to determine the most suitable strain for each locality.

Distribution Scheme.

To meet the above points preliminary distributions were made only to certain reliable cultivators who might be expected to give the strain distributed to them a fair trial. At Talang, Kuala Kangsar, a test station was established last year where suitability of certain strains for the locality was tested. Another test station was laid out at Selinsing by the Penghulu. In several other localities where cultivators have gained sufficient confidence in the selected strains for the purpose, practical test stations have been arranged for the coming season by supplying a number of strains to the same number of cultivators, one strain to each. As far as possible measurements of comparative yields between selected strains and local varieties have been made and recorded. Inspections of the selected strains in the field have been carried out in so far as time would allow.

Distributions made for season 1921-22.

In Feburary 1921 the District Officer, Kuala Kangsar, Perak, applied to the Department for five bags of selected seed for distribution in his district. This amount was later reduced to 2 bags each containing about 25 gantangs, one of Seraup No. I. the other of Radin No. I. Partly by reason of the partiality of cultivators for their local varieties as mentioned earlier, and partly because of a prejudice created against Government-introduced seed owing to badly controlled distribution during the food shortage period in the later years of the war, the demand for the selected seed was so small that the District Officer distributed only 20 gantangs as follows:—

To Whom.	Seraup No. I.	Radin No. I.
Penghulu, Chegar Galah	2 Gantangs	2 Gantangs
,, Senggang.	1 ,,	4 ,,
Assistant Penghulu, Pulau Kimiri	2 ,,	2 ,,
Penghulu, Kampong Buaia	2 ,,	2 ,,

It was agreed that the Inspection Staff should, as far as other work permitted, keep in touch with the seed supplied. In every case the padi grew well and returns were good but most of the cultivators stated that the yields were no better than those obtained from local varieties. In these cases seed was not kept for sowing in the season following. There were exceptions in the case of localities in the mukims of Kampong Buaia, Chegar Galah and Pulau Kimiri where redistributions of seed were made.

Re-distribution by cultivators for 1922-23 season.

1. Kampong Buaia mukim.

(a) Bendang Ulu Papan. The Ketua here was supplied with 1 gantang of Seraup No. I seed for 1921-22 season. For 1922-23

season he distributed over 90 gantangs or sufficient to plant about 25 acres.

(b) Kampong Lalang. The Ketua grew 1 gantang of Seraup No. I in 1921-22 season. Of the seed obtained he re-distributed over 35 gantangs or sufficient to plant about 10 acres. Comparative yields for these two localities will be found tabulated below.

2. Pulau Kimiri mukim. Redistributions were made here of 13 gantangs of each.

3. Chegor-Galah mukim. A little redistribution was made in the locality of Jawang.

TABLE I.

Record of yields 1922-23 season from pure strains grown from redistributions made by cultivators who grew the seed originally distributed in 1921-22 seasons, with some comparative local variety yields.

(1) Distributed by Haji Ishak, Ketua, Bendang Ulu Papan.

Locality grown.	Pure strain or local variety.	Maturation period.	Yield per acre in gantangs.
Bendang Ulu Papan.	Seraup No. I.	8 months	650 pure strains
,,	,,	,,	570 ,,
,,	Padi Bemban	,,	700 } Local varieties
,,	Padi Chantek	7½ ,,	590 }
Bendang Gapis.	Seraup No. I.	8 ,,	425 } Pure Strains
Bendong Ulu Papan Ekor.	,,	,,	490 }
,,	Padi Chantek	7½ ,,	506 Local variety

(2) Distributed by Anjang Rahim, Ketua, Kampong Lalang.

Kampong Lalang	Seraup No. I.	8 months	880 Pure strains
,,	,,	,,	690 ,,
,,	,,	,,	720 ,,
,,	,,	,,	775 ,,
,,	,,	,,	740 ,,
Paya Panjang	,,	,,	750 ,,
Kampong Stor	,,	,,	650 ,,
Bendang Pulai	,,	,,	647 ,,
,,	Padi Machang	,,	575 Local variety

No measurements were taken of the padi redistributed in Pulau Kimiri mukim.

At Jawang the pure strains grew remarkably well, but a little before harvest swarms of rats made their appearance and did so much damage that it was decided no reliable measurement of yield was possible.

TABLE 2.

Record of yields 1922-23 season from pure strains distributed, with some comparative local variety yields.

District of Kuala Kangsar.

Mukim.	Locality.	Pure strain or local variety.	Maturation period.	Yield per acre in gantangs.
Kampong Buaia	Kg. Lalang	Radin No. 1	7 months	570 Pure strains.
,,	,,	,,	,,	480 ,,
,,	Paya Panjang	Radin No. 7	7½ months	410 ,,
,,	Kembai Batu	,,	,,	620 ,,
,,	Kg. Lalang	Radin Che Mah	7 months	560 Local varieties.
,,	,,	Padi Bujang Berinei	,,	600 ,,
,,	Kg. Stor	Radin Che Mah	,,	485 ,,
Lubok Merbau	Langkor	Seraup Kechil No. 20	8 months	660 Pure strains.
,,	Kubang	,,	,,	610 ,,
,,	Tanah Merah	Radin No. 7	7½ months	600 ,,

District of Larut and Matang.

Mukim.	Locality.	Pure strain or local variety.	Maturation period.	Yield per acre in gantangs.
Simpang	...	Seraup No. 36	8 months	350 Pure strains.
,,	...	Muda Che Alli	,,	355 Local variety.
Bukit Gantang	B. Jelutong	Seraup No. 36	,,	490 Pure strains.
,,	,,	Radin No. 11	7 months	485 ,,
,,	,,	Padi Puteh	,,	460 Local varieties.
,,	,,	,,	,,	480 ,,
Tupai	Larut Ulu	Radin No. 1	,,	225 Pure strains.
,,	,,	,, 13	,,	330 ,,
,,	Larut Tengah	,, 1	,,	560 ,,
,,	,,	Padi Chantek	7½ months	415 Local variety.
,,	Parit Mentri	Radin No. 13	7 months	460 Pure strain.
,,	,,	Padi Pahit	7½ months	540 Local variety.

TABLE 3.

Record of yields at Talang Test Stations 1922-23.

Pure strains grown in quantity.

Pure strain or local variety.	Yield per acre.	Mean yield for each strain.
Radin No. 1	460	
,,	470	
,,	380	455 gantangs per acre.
,,	495	
,,	450	
,,	480	
Radin No. 2	580	
,,	375	
,,	430	465 gantangs per acre.
,,	360	
,,	490	
,,	550	
Radin No. 7	450	
,,	450	
,,	430	475 gantangs per acre.
,,	455	
,,	600	
Comparative tests of pure strains grown by the Ketua.		
Radin No. 1	460	
,, 2	580	
,, 3	380	
,, 7	450	
,, 13	600	
Local Varieties.		
Radin Puteh	340	
,,	440	470 gantangs per acre.
,,	510	
,,	585·	

Pure strain pulut varieties.	Local pulut.
Hitam F.S. 644-490 gantangs per acre.	Pulut Pipit—595 gantangs per acre.
Cheakbong F.S. 670-600 gantangs per acre.	Pulut Serai—580 gantangs per acre.

REMARKS ON ABOVE TABLES.

I propose to preface my remarks by some observations upon the pure strains and upon the introduction of such to new localities.

The Pure Strains.—These have been isolated from amongst a large number of varieties selected from throughout the Federated Malay States. When grown at Titi Serong those chosen for distribution have shown on consecutive comparative tests with local varieties a higher yield of from 20% to 25%. Other advantages claimed for the pure strains are uniformity of ripening within each strain and a higher weight per unit volume as compared with local varieties. Hence the claim that production throughout the country will be increased by replacing present varieties by our pure strains has reason to support it.

Introduction to fresh localities.—Padi, in common with many other crops belonging to the same Natural Order, is very susceptible to changes in environment. This point has a bearing on the distribution of pure strains of padi in that it gives some ground for assuming the possibility that a pure strain introduced to a fresh locality may be capable of higher yields after being grown for several consecutive years in the locality than upon its first introduction. In other words the susceptibility to environment also suggests capability of adaptation to environment. This shows the impossibility of judging results from one or two years records of comparative yields and emphasises again the need for test stations and systematic control of distribution.

Table 1.—This table is concerned with one pure strain, Seraup Kechil No. 1. At Bendang Ulu Papan the local variety Bemban yielded 700 gantangs per acre as against 650 gantangs from Seraup Kechil No. 1. The local variety is a Seraup Kechil. It is a striking example of a variety being eminently adapted to local conditions. Another pure strain of Seraup Kechil will be introduced to this locality next season for further comparison. It is proposed also to raise a pure strain from the local Bemban for comparison with the existing strains at Titi Serong. At Kampong Lalang (including other similar bendangs in the locality) the mean of the measurements of yield from eight separate plots was over 730 gantangs per acre as against a yield of 575 gantangs from the best local variety "Machang" In this instance the yield of the pure strain may be safely assumed to be over 25% higher than the best local yield, for the "Machang" may be relied upon to be the very best in the locality, having been selected for comparison by the cultivators themselves.

The pure strain used here and at Bendang Ulu Papan is not our best strain of the variety.

Two better strains will be introduced next season at both localities. The bendangs of Bendang Ulu Papan Ekor and Bendang Gapis are not so suitable for Seraup as the remainder of the bendangs mentioned and trials with pure strains of other varieties will be made next season.

Table 2.—All the pure strains mentioned here have been grown for only one season in the localities mentioned. As a result of more thorough knowledge of the bendangs and requirements for the various localities, pure strains of Seraup and Padi Pahit will be introduced next season in several instances to replace or supplement varieties of Radin. This applies especially to some localities in Larut District. Trials with Radin No. 1 will be discontinued or almost so. Radin No. 7, 11 and 13 will be continued within certain localities and Radin No. 4 introduced to certain bendangs. Trials with Seraup Kechil No. 20 will be continued at Lubok Merbau in Kuala Kangsar District. Little more can be said regarding table 2 excepting that it will provide a record for comparison with next season's records.

Table 3.—As a result of this year's test it has been decided to utilise Radin No. 13 for the major portion of Talang test station. Further trials will be made with all the strains used this year and Radin No. 4 and 11 will be introduced. Seraup No. 36 and 52 will be utilised to plant up a low lying part of the station. With regard to Radin Puteh which was used for comparison, it was found, unfortunately only when too late, that this variety is the progeny of a selected padi introduced to the locality some years ago by the Economic Botanist who used it to plant up the station in connection with experiments undertaken by him. It is therefore not really a local variety but one of the Titi Serong pure strains.

The average yield per acre of between 450 and 475 gantangs obtained from the station is much higher than the local yields of the year for places in the same mukim.

Talang Test Station.

The portion of the station cultivated this year was about 12 acres in extent. The padi was grown by local Malays who received land free of rent on condition that pure strain seed would be grown and that cultivation would be reasonably well attended to. The produce, excepting what is needed for seed in the following season, becoming the property of the cultivator. This method proved sufficiently satisfactory to warrant its continuance here and adoption for other test stations which may be established. Preliminary cultivation was not so good this year as it should have been as over most of the area only the "Tajak" was used. For the type of land something more is needed and the cultivators were informed that ploughing and rolling must be done next season, being given the option to promise to do so or to give up the land. All save one complied.

Reference to the table 3 for yields of Radin No. 2 will illustrate the effects of cultivation on yield. In the two plots yielding 580 gantangs and 550 gantangs per acre respectively, both the "Tajak" and "Golek" were used, whereas on the other four plots giving a mean of just over 400 gantangs per acre the "Tajak" only was used. The major portion of the bendang was planted with Radin Nos. 1, 2 and 7. The other strains shown in Table 3 were planted in small plots on an uniform piece of land for comparative trials. The few pure strains of padi pulut were introduced in response to a request by

the cultivators that each should be allowed to grow a small quantity of pulut padi.

CONCLUDING REMARKS.

Pressure of other work and limitation of staff has not permitted the carrying through of all that was intended. In many instances no measurements of yields were made and in others no records of local yields for comparison were obtained. A little progress however has been made and a gradual tendency towards better execution is hoped with increased experience by the staff and increased confidence of the cultivators in both the staff and in the pure strains of padi advocated by us.

The above progress report was written when I was Assistant Agricultural Inspector, Perak North. Its publication was postponed to allow of consideration of the advisability of including in the one report results obtained from the distribution of pure strains of padi by the whole of the Inspection Staff throughout the Federated Malay States and Straits Settlements.

After careful consideration it appeared to me when acting Chief Agricultural Inspector more desirable to publish the original report, as remarks therein on the Distribution Scheme. need for methodical control and the careful test and selection of suitable pure strains for particular localities apply equally throughout Malaya. The inclusion of all results would entail more voluminous tables without any corresponding material addition to the text. Below is a brief summary of pure strain distribution by the Inspection Division in other districts.

Perak South.—Comparative trials were made at Gopeng with four pure strains of Radin and two pure strains of Seraup Kechil.

Pahang East.—At Paya Kelat Rendang, Pekan, comparative trials were made with pure strains of Radin and Pahit.

Province Wellesley.—In the North District seed was distributed in ten localities to 17 cultivators, the pure strains used being Radin Nos. 1, 7 and 15, Seraup Besar 15, and Seraup Kechil 36. In the Central District pure strain seed of Radin 1 and 2 was issued to five cultivators. In every case yields were obtained and recorded as well as yields of local varieties for comparison.

A test station was established last season at Pertang To' Jaya in which comparative tests were made of eight pure strains, Radin Nos. 7 and 13, Seraup Besar 15 and 617, Seraup Kechil 36, 52 and 371. The best yields obtained were from Radin 7, Seraup Kechil 52 and Seraup Besar 16 which yielded at the rate of 590, 520 and 512 gantangs respectively.

Malacca.—Comprehensive trials were arranged in this settlement in 31 mukims representing the main padi growing areas, the following pure strains being used:—

Radin 1, 7, 11 and 13, Seraup Kechil 52,371, Pahit 1 and 4. Records of yields of the pure strains were obtained from 57 plots situated in various parts of the Settlement and of local varieties for comparison from 35 plots. The yields obtained in many instances are very promising.

General Remarks.—In a great many instances the yields obtained from pure strain padis, even in the first trial, are such as to warrant the belief that each such strain will become extensively planted after a few seasons in the locality to which it has been introduced and the result will be an increased yield generally for the locality. In other instances there are indications that, although the pure strain yields were not higher than that of local varieties, the pure strain used is capable of adaptation to its new environment and will give increased yields after a few seasons. The yield records as a whole coupled with the experience gained last season, are of great use in helping the Assistant Agricultural Inspector concerned to form an opinion as to the strain most likely to prove suitable for any particular locality.

Received for publication 14th July, 1923.

LONDON MARKET PRICE LIST, 3rd QUARTER 1923.

OIL SEEDS.

Castor (Bombay)	- £19 per ton.
Coconut (Desiccated)	- 37/- per cwt.
Copra (Ceylon)	- £26 per ton.
„ (Straits)	- £24 „
Cotton (Egyptian)	- £10—£11 per ton.
„ (Bombay)	- £9 £9.5 „
Croton	- 27/6—32/6 per cwt.
Gingelly (Chinese)	- £23 per ton.
„ (Bombay)	- £22 „
Groundnuts (Gambia) undecorticated	- £17.10 per ton.
„ (Chinese) decorticated	- £21.10 „
Linseed (Bombay)	- £19.7.6 „
„ (Plate)	- £18.5 „
Palm Kernels (West Africa)	- £16.10 „

OILS.

Castor (Madras)	- 49/- per cwt.
„ (Pharmaceutical)	- 61/- „
„ (1st pressing)	- 56/- „
„ (2nd pressing)	- 55/- „
Coconut (Cochin)	- 47/- „
„ (Ceylon)	- 38/3 „
Cotton seed (Egyptian, crude)	- 39/6 „
„ (Bombay)	- 37/- „
Groundnut (Oriental, crude)	- 46/- „
„ (English)	- 43/- „
Linseed (Calcutta)	- 41/- „
„ (Plate)	- 40/6 „
Palm (Lagos)	- £32.10 per ton.
„ (Congo)	- £28 „
Palm kernel	- 35/6 per cwt.

OIL CAKES.

Coconut	- £7—£8 per ton.
Groundnut (Semi-decorticated)	- £10 „
„ (undecorticated)	- £8 „
Linseed	- £10 „
Palm kernel	- £5 „

ESSENTIAL OILS.

Cajeput	- 3/3—3/6 per lb.
Camphor (Chinese, crude)	- 3/- „
„ (Japanese, refined)	- 3/6 „
„ (oil)	- 75/-—80/- per cwt.
Cinnamon (Ceylon, leaf)	- 4d. per oz.
Citronella (Ceylon)	- 3/6 per lb.
„ (Java)	- 4/2 „
Clove	- 7/- „

OIL CAKES—*Contd.*

Lemon grass (Cochin)	-	2½d. per oz.
Lime (West Indian, expressed)	-	7/-—7/6 per lb.
„ (West Indian, distilled)	-	3/6—3/9 „
Nutmeg	-	4/6 „
Patchouli (Penang)	-	27/-—30/- „
Vetiver (Bourbon)	-	21/6 „
Ylang Ylang	-	15/-—16/- „

SPICES.

Capsicums (East Indian)	-	40/-—45/- per cwt.
„ (Nyassaland)	-	60/-—65/- „
Chillies (Zanzibar)	-	65/-—75/- „
„ (Nyassaland)	-	85/-—95/- „
„ (Japan)	-	125/- „
Cinnamon (Ceylon)	-	7½d.—10½d. per lb.
Cloves (Zanzibar)	-	1/1 „
„ (Penang)	-	2/6—3/- „
Ginger (Japanese, Cochin)	-	70/-—80/- per cwt.
„ (Jamaica)	-	180/-—200/- per cwt.
Mace (Bombay & Penang)	-	1/4—1/8 per lb.
Nutmegs (Singapore & Penang)		
110's	-	10½d „
80's	-	1/1½d. „
64's—57's	-	1/7—1/8 „
Pepper (Singapore, black)	-	4d. „
„ (Singapore, white)	-	6d. „
Turmeric	-	45/-—70/- per cwt.

DRUGS.

Areca	-	37/6—40/- per cwt.
Cocaine (hydrochloride)	-	15/9 per oz.
Ipecacuanha (Matto Grosso)	-	8/- per lb.
Quinine Sulphate	-	2/8 per oz.

NATURAL DYESTUFFS & EXTRACTS.

Annatto (seed)	-	10d. per lb.
Cutch (Borneo, solid)	-	40/-—45/- per cwt.
Gambier (block)	-	45/- „
„ (cubes)	-	62/6—65/- „

GUMS.

Damar (Singapore)	-	30/-—150/- „
„ (Batavia)	-	120/-—160/- „
Dragon's blood (reeds)	-	£18—£20 per cwt.
„ „ (lump)	-	£11—£28 „

FIBRES.

Cotton (F. M. American)	-	15.38d. per lb.
„ (Egyptian Sakellaridis)	-	16.35d. „
Hemp (African sisal)	-	£36 per ton.
„ (Manila, J. Grade)	-	£80 „
„ (New Zealand)	-	£33 „
Kapok (Java)	-	1/2½ per lb.
„ (Indian)	-	11d. „

FOODSTUFFS.

Cocoa (Ceylon, plantation)	-	60/-—85/- per cwt.
Coffee (East India)	-	85/-—120/- „
Sago (pearl)	-	24/-—30/- „
„ (flour)	-	16/-—17/- „
Sugar (White Java)	-	49/6—50/- „
Tapioca (Penang, flake)	-	3¼d.—3¾d. per lb.
„ (Penang, flour)	-	18/-—22/- per cwt.

MISCELLANEOUS CHEMICALS.

Acetic acid (glacial)	-	£71 per ton.
„ (80% comml.)	-	£50 „
Acetone (pure)	-	£130—£135 per ton.
Ammonia (.880)	-	£32—£34 „
Calcium acetate (grey)	-	£22—£23 „
Citric acid	-	1/6 per lb.
Creosote	-	9d. per gallon.
Formalin (40% vol.)	-	£97—£98 per ton.
Lime juice (raw)	-	2/9 per gallon.
„ (conc.)	-	£22 per basis.[1]
Sodium bisulphite	-	£19—£20.10 per ton.
„ sulphite (anhydrous)	-	£27.10—£29 „

Received for publication September 26th 1923.

1 Basis=108 gallons, 64 ozs. Citric acid per gallon.

THE

Malayan Agricultural Journal.

Vol. XI. December, 1923. No 12.

OBITUARY.

THE LATE THOMAS CHARLES NOCK.

Assistant Agricultural Inspector, Department of Agriculture S.S. and F.M.S.

WE have to record with deep regret the death of Mr. T. C. Nock which occured on 27th October 1923 at the Radium Institute London.

Mr. Nock was born in Ceylon on September 1st, 1883, and was the son of Mr. W. Nock, formerly Curator of the Hakdala Gardens, Ceylon.

Mr. Nock was employed as a Surveyor by the Government of Ceylon from 1901—1903, and came to the Straits Settlements in 1904 in the same capacity. He was appointed Assistant Inspector of Coconut Trees in Selangor in 1907, and was transferred to the Federal Government in 1908. In 1915 he was appointed Acting Assistant Agricultural Inspector, and in 1921, was confirmed in the appointment.

During his tenure of Office Mr. Nock earned the regard of all who came into contact with him by his unfailing courtesy, cheerfulness, and willingness to assist specialists with his extensive knowledge of general agriculture in Malaya.

The Officers of the Department offer their deepest sympathies to the family of Mr. Nock in their bereavement.

STUDIES ON HEVEA LATEX.

I. COAGULATION.

By W. N. C. Belgrave.

THE practical importance of latex coagulation led to much work in the experimental years of factory technique from 1911 to 1915; since methods have become fixed, less attention has been given to the subject. The necessity of a clear understanding of the process remains however as important as ever, and in addition some new cognate problems have arisen; of these the preservation of latex, and the problem of brown bast may be cited.

General.

Latex as it issues from the tree is well known to consist of an enormous number of hydrocarbon globules, for the most part spherical, of sizes varying from 2—0.5 microns (1 micron = .001 mm), in vigorous Brownian motion, suspended in an aqueous medium which is a dilute solution of nitrogenous (protein) bodies, sugars l-methyl inosite and mineral salts. There are also present bodies of a resinous nature, one or more alcohols akin to phytosterol, and a small amount of a lecithin-like substance.

"Coagulation" is generally taken to mean the separation and coalescence of the rubber globules to a coherent, somewhat elastic clot leaving, when the process is complete, a perfectly clear liquid—serum. Beadle and Stevens[1] and Whitby[2] pointed out that separation could take place without the formation of a clot, and that either 'creaming,' 'flocculation,' or 'coagulation' could occur depending on the size of the aggregates of globules formed on separation, the numbers composing the aggregates increasing progressively up the series.

In the tropics, coagulation (in the strict sense) usually commences within a few hours of outflow and progresses steadily from 12—24 hours. At the same time there is considerable bacterial activity resulting in the development of acidity and evolution of some CO_2. The perfection of natural coagulation varies according to the conditions, whether anaerobic or aerobic—in the former it is usually perfect or nearly so, in the latter secondary putrefactive changes occur, resulting in the production of alkalinity and partial coagulation only. Artificial coagulation may be brought about in varying degrees of perfection by small quantities of dilute acid, neutral salts of the di- and trivalent metals, heat, an electric current, and protein precipitants. Coagulation is inhibited or retarded by some antiseptics, a low temperature and alkalies.

The object of this paper is to put forward a restatement of the position, together with a simple physico-chemical theory of coagulation which, it is believed, fits the observed facts at least as well as the

only other consistently stated theory—that of enzyme action. Other writers who have rejected the enzyme theory, have not clearly stated how certain well defined phenomena can be explained.

It is proposed to consider first the state of rubber in latex, then the current theories of coagulation, followed by the writer's theory, and some practical deductions to be drawn therefrom. For the purpose of reference full use will be made of Whitby's comprehensive work—"Plantation Rubber" which gives an admirable account of the position in 1920.

THE STATE OF RUBBER IN LATEX.

There has been considerable discussion on the physical state of rubber in latex, that is, whether it is a solid or liquid. As Whitby points out opinion now tends to the former view. De Vries[3] has recently stated that the matter has ceased to be of importance with the changing views of heterogenous systems, the old emulsion suspension anthithesis having given place to that of lyophile—lyophobe disperse phases, with caoutchouc in the former class due to a coating of protein. From one point of view this is correct, but from another it is of some importance to know whether separation of the rubber substance is due to physical causes only or whether in addition there are chemical changes such as polymerisation.

De Vries[4] has himself supplied an indirect proof of the absence of fundamental change by calculating the specific gravity of the rubber substance in latex from the specific gravities of latex and serum and comparing it with that of coagulated rubber. The writer has developed two other lines of work; one the volume changes, the other the temperature changes on coagulation.

1. *Volume Changes on Coagulation.*

A test tube of 250ccs capacity, fitted with a cork and narrow bore tube was filled with latex (D.R.C.* 20%) to which 2% of 10% acetic acid had just been added. After coagulation, which was rapid and complete, water was added from a burette to bring the volume back to a mark on the narrow tube.

Two experiments gave contractions of:—(a) 0.5ccs, (b) 0.3ccs, and these are well within the limits of experimental error due to air bubbles included on filling the tube and liberated on coagulation.

Taking a mean figure of 0.4ccs as the contraction, and (for this purpose) the specific gravity of rubber before and after coagulation as 1.0, we have

$$\text{Volume of rubber} = \frac{20}{100} \times 250 = 50 \text{ ccs.}$$

i.e. the change of volume on coagulation does not exceed 0.8%, a negligible figure.

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* D.R.C. = Dry rubber content.

2. *Temperature Changes.*

A cylindrical Dewar vacuum flask was used as calorimeter, with a thermometer graduated in 0.1°C and reading by estimation to 0.01°C. The water equivalent of the calorimeter when half-filled was 21 grms and the rate of change over the range 20—30°C (air temperature—26°C) did not exceed 0.02°C per minute.

In order to ensure rapid coagulation and consequent minimum heat loss, 10% of strong hydrochloric acid was used for coagulation.

Preliminary experiments showed that the heat evolved on dilution of the strong acid caused a rapid rise in temperature, followed by a slight fall as the calorimeter came into equilibrium, and then a slow steady rate of cooling, which was attained in less than 2 minutes.

On the addition of HCl to latex there was a similar rapid rise and initial fall, but after 2—3 minutes as the latex could be felt to thicken, a slight but constant rise was observed; at the end of the 5th minute coagulation had proceeded to such an extent as to immobilise the stirrer. No further rise took place, and it seems fair to take the extent of this second rise as the extent of the temperature change on coagulation.

Two experiments gave:

100 ccs of strong (40% D.R.G.) latex and HCl.

Interval.	(a) Temperature.	(b) Temperature.
0'	25.10°C	25.05°C
0.30"	28.50	28.30
1	27.50	27.40
2	27.40	27.75 thickens
3	27.50 thickens	27.85
5	27.95	27.80 coag.
10	27.90	27.75
	0.55°C	0.45°C

that is a mean second rise of 0.5°C for the coagulation of 40 grms of rubber, or assuming a specific heat for latex equal to that of water (too high a value) heat evolved = (110 × 21) × .5 = 65.5 calories or a maximum possible change of 1.6 calories per gram of hydrocarbon, which is such a small quantity as to suggest that no deep seated chemical change or change of state has occurred, that is that rubber in latex exists as a solid.

Thus both lines of work confirm the modern view that caoutchouc exists as such in latex, and that coagulation may be regarded as a problem of separation and coalescence uncomplicated by more radical changes.

Theories of Coagulation.

(a) *Bacterial.*

The bacterial theory of coagulation, expounded by Eaton and Grantham[7] and Vernet[6] holds that natural coagulation is due to acid formed by the action of bacteria.

In support of this the following facts are adduced.

(*a*) Latex[5] was heated in plugged flasks in an autoclave for brief periods (brief to avoid heat coagulation). Flasks kept plugged remained fluid, which those afterwards exposed to infection coagulated. It has been objected that the period of heating was insufficient for certainty either of sterilisation or enzyme destruction, but the objection seems invalid if the experimental results are accepted, since it would be a remarkable coincidence that flasks left unplugged were insufficiently while plugged flasks were sufficiently heated.

(*b*) Vernet reports that latex collected by him in the field under sterile conditions remained sterile.

A considerable number of observations were made by the writer on this point. Bacteria where present, were demonstrated by making a cover-slip smear of latex or serum, drying, fixing by heat and staining with hot Carbol-Fuchsin. washing in water, drying, soaking in xylol (to swell and dissolve or render transparent the rubber film) and mounting in Canada Balsam.

All attempts at collecting sterile latex from the tapping cut failed, and eventually the following procedure was adopted — the outer scaly dead bark was removed and the tree surface scraped till latex just started to exude in minute drops; the exposed part was then scrubbed with 96% alcohol, and the last traces of alcohol flamed off, while still burning a cover was applied —(a Graham dialyser was found convenient), then a sterilised (alcohol-flamed) gouge was used to remove a cylinder of bark about ½" diameter. The out-flowing latex was collected in a sterilised pipette and placed in a small sterilised test tube, the usual precautions being observed.

Even with such precautions, a considerable percentage of failures is to be expected because of the many opportunities for infection. The following are typical of the results obtained: —

30- 9-21.	Four tubes put up.
1-10-21.	One coagulated – bacteria present.
	3 fluid – one examined, bacteria absent.
3-10-21.	2 remainder coagulated — bacteria present.
3-10-21.	3 tubes put up.
5-10-21.	2 coagulated — bacteria and gas.
	1 fluid—no bacteria.
11-10-21.	4 tubes put up.
12-10-21.	All 4 tubes coagulated — all bacteria.
17-10-21.	6 tubes put up.
20-10-21.	2 remained fluid no bacteria, bacteria in those coagulated.

A total of 50 tubes was examined, in approximately 30% of cases there was delayed coagulation associated with delay in appearance of bacteria.

Such results are evidence that bacteria play an important part in coagulation of latex, but cannot be considered absolutely to exclude

the operation of an enzyme in the coagulation of latex obtained in the usual way, since a higher proportion of sap from the cortical tissues must be present in the latex used in these experiments and this might inhibit enzyme action.

(c) Another observation in favour of the bacterial theory is the well-known early coagulation of latex on wet mornings. The writer has in such cases invariably found the coagulated latex to be swarming with bacteria; due doubtless to a high density of infection derived from water running down the bark and over the tapping cut.

The three lines of evidence given above are strongly in favour of a bacterial theory of coagulation, but such a theory in its simplest form fails to provide a complete explanation of observations by Whitby, Barrowcliff and Campbell.

The Enzyme theory.

Whitby[2] considers that the action of small quantities of dilute acids — whether added as such, or formed by bacterial action — in bringing about coagulation is indirect and is due to the activation of an enzyme. In support of this, the following observations are adduced:—

(1) Latex coagulates readily in the presence of chloroform or toluene, antiseptics which are considered not to inhibit enzyme action, but does not coagulate in presence of formalin, which is known to paralyse or destroy enzymes, in addition to acting as an antiseptic. Cyanides also inhibit coagulation.

(2) Campbell[7] has shown that calcium salts accelerate coagulation to a much greater extent than barium salts. This is correlated with the known acceleration of the clotting of milk and blood by calcium salts. Conversely the calcium precipitants, oxalates or fluorides, markedly inhibit coagulation.

(3) Barrowcliff[3] has shown that latex may be dropped into boiling water without the occurrence of coagulation; on standing or on the addition of small quantities of acid, coagulation does not occur, but may be brought about by the addition of a drop of fresh untreated latex.

(4) Whitby[2] has demonstrated the existence of a 'gap' in acid coagulation, small quantities of acid bringing about coagulation, while larger quantities of the stronger acids inhibit it, still larger quantities again cause coagulation which is now very rapid. This is assumed to be due successively to enzyme acceleration, enzyme inhibition, then to physical action.

(5) The slowness of action of small quantities of acid is taken by Whitby[2] as evidence of enzyme action.

(6) In general, a strong analogy to the clotting of milk and blood is claimed.

It is proposed to examine these claims in detail.

(1) *The action of antiseptics.*

The assumption here involved has been found to be incorrect, neither toluene, chloroform nor thymol functions as an antiseptic in presence of latex.

20ccs of concentrated (32% D. R. C.) and dilute (16.5% D.R.C.) latex was put up in open test tubes with:—

(*a*) 1cc chloroform (*b*) 1cc toluene (*c*) .5 grs. powdered thymol, (*d*) (*e*) and (*f*) with 5 ccs of saturated aqueous solutions of the above. The (*a*) (*b*) and (*c*) tubes showed small clots after 1 hour, the remainder were normal—next day all the tubes showed coagulation and abundant bacteria were present.

Similar tubes with the addition of .5 ccs formalin remained fluid and sterile.

In addition to antiseptic action, formalin is known to have a specific action on proteins, retarding their coagulation. Some such action on latex is suggested by the fact that more acid i.e. a higher hydrogen ion concentration is required to bring about coagulation in formalin-preserved than in normal latex. The total quantity however, is still within the limits which are said by Whitby to act indirectly only — yet the enzyme is supposed to have been inhibited.

In the case of cyanide, addition of acid sufficient to overcome the buffer action of the weak acid results in coagulation at the usual hydrogen ion concentration i.e. cyanides have no specific action.

TABLE I.

An approximately 2% solution of commercial potassium cyanide was neutralised to phenol red with HCl.

10ccs of the solution diluted to 50ccs with water, required 2.5cc N/10 HCl to bring it to pH 4.6 (methyl red). 10ccs of solution was then added to 50ccs of dilute latex (D.R.C. = 20%) and N/10 HCl added.

	50ccs latex.	50ccs latex + 10ccs neutral cyanide.
+ 3ccs N/10 HCl.	5.3 pH	5.7 pH
+ 4	4.9	5.4
+ 5	coagulates	5.4
+ 6	,,	5.2 Thickens
+ 7		5.0 ,,
+ 8		coagulates

i.e. an excess of 3 ccs of acid is required for coagulation corresponding to the theoretical difference of 2.5ccs due to the added cyanide.

The obvious explanation of the failure of some of the antiseptics is absorption or possibily solution in the hydrocarbon globules, just as the disinfecting power of mercuric chloride may be materially reduced in presence of proteins.

(2) *Influence of salts.*

Campbell's observations on the preponderating influence of calcium over other neutral salts, while suggestive, is not proof of enzyme action. Recent work has shown that the "valency law" is only a first approximation, and that there are pronounced differences in equivalent precipitating power among metals of the same valency, *e.g.* Lewis (p. 34) quotes the work of Oden on the precipitation of colloidal sulphur, which showed that the precipitating power of caesium chloride was approximately one hundred times that of lithium chloride, and that of barium chloride was equal to that of strontium chloride and double that of calcium chloride. The differences found are ascribed to different degrees of adsorption, and except by analogy with milk and blood there seems to be no valid reason for assuming the specific action of calcium salts to be due to activation of enzyme action and not to selective adsorption; there are however, further facts to be considered.

Campbell found using 1% solutions of calcium and barium chlorides, that 1—5cc. $Ca\ Cl_2$ to 1000 of latex (30—35% D. R. C.) produced no effect in 3 hours, while with 10cc small clots formed in 20 minutes, with 25cc coagulation started in 10 minutes, and 50ccs caused coagulation to start immediately. 1—25cc of $Ba\ Cl_2$ produced no coagulation in 3 hours, and 50 cc caused coagulation to start in 10 minutes.

The form of calcium chloride used is unfortunately not particularised hence it is impossible with certainty to recalculate these results on the only true basis, viz. effect of equivalent (gram-molecular) solutions. If anhydrous $Ca\ Cl_2$ was employed, in equal volumes calcium was present in more than double the equivalent concentration of barium ($Ca\ Cl_2$=110; $Ba\ Cl_2 2H_2O$=243); on the other hand if $CaCl_2 6H_2O$ was employed the equivalent concentrations were nearly equal ($Ca\ Cl_2\ 6H_2O$=218.) In the former case, Campbell's results would need no further discussion.

The writer found however, that when molar solutions were used, that for limiting quantities calcium chloride was more efficient than barium chloride—the figures approximating to those of Campbell. There are two further considerations:—

(*a*) If the effect of the metallic ions is not additive, but is specific, whether acting physically or through an enzyme, the calcium normally present in latex would assist added calcium, but not barium.

Campbell found that 1% of 1% calcium chloride just started coagulation—assuming that he used the hydrated salt, this would give an addition of .01 x 56/218, grams of Ca expressed as Ca 0=.0026 grs of Ca 0. and this is only a 25% increase on the *dialysable* calcium found by Beadle and Stevens* (Ca 0=013%).

(*b*) The smaller solubility of barium salts compared with those of calcium must be considered. The same authors showed that the *dialysable* sulphate in latex (as SO_3) was .008%. Calcium sulphate

* Whitby *Plantation Rubber* p. 62.

is soluble to the extent of 0.2% in water and so will not be removed in the concentrations used in these experiments, but barium sulphate is in a different category ; 0,008 grs of SO_3 will precipitate the barium in $\frac{243}{80}$ x .008 grs=.025 grs. and this is contained in 2.5ccs of a 1% solution i.e. 25 ccs of such solution must be added to 1000 ccs of latex before barium ions will be present in the solution to any appreciable extent—this alone amply suffices to explain the greater apparent efficiency of calcium, without taking into account the possible formation of organic salts.

If it is admitted that calcium salts may physically assist in coagulation, the action of calcium precipitants would follow. There is however the possibility of physical action ; just as salts of divalent metals accelerate, so salts of divalent acids may inhibit coagulation. Unfortunately for work on the particular point, practically all di- and tri-valent calcium salts are insoluble in water ; there is however one exception,—calcium sulphate is soluble to the extent of 0.2% at 30°C and as the percentage of dialysable calcium as oxide in latex is in the neighbourhood of 0.02%, any action of sulphates cannot be due to precipitation of calcium. To make certain that the excess of added sulphate does not cause precipitation, the following experiment was tried.

4ccs of $\frac{M}{10}$ $Ca\,Cl_2$ solution (=.022 grs Ca O) was added to 100 cc water and then 2cc 2M Na_2SO_4 was run in, no precipitate resulted. (On addition of 2cc M potassium oxalate, calcium oxalate was precipitated). The effect of sulphate was then tested as in Table II.

TABLE II.

Half-strength latex (D.R.C. = 20%) was used in each experiment.

	pH value.	State after 5'	2 hr.	24 hrs.
50cc Latex + 3ccsN/10 HCl	5.0	Thick.	Coagulated.	—
,, ,, + acid + 0.2ccM. Na_2SO_4	5.0	,,	,,	—
,, ,, + ,, + 0.4 ,, ,, ,,	5.0	Fluid.	Half-coag :	coagulated.
,, ,, + ,, + 1.0 ,, ,, ,,	5.1	,,	Fluid.	do
,, , + ,, + 2.0 ,, ,, ,,	5.1	,,	,,	do
,, ,, + ,, + 4.0 ,, ,, ,,	5.4	Thick.	Coagulated.	—

After 24 hours all coagula showed abundant bacteria.

TABLE III.

Action of oxalates.

Latex as in Table II. Molar $K_2C_2O_4$ neutralised to phenol red by addition of HCl.

	pH after addition.	5'	State after 1 hr.	24 Hrs.	pH after 24 hours.
50cc + 3cc N/10 HCl	5.0	Thick	Coagulated	—	—
50cc + acid +1cc oxalate	5.4	Slight thickening	Half-coagulated	Coagulated	5.2
50cc + acid +3cc oxalate	5.6	Fluid	Fluid	Coagulated milky serum	5.1
50cc + acid +5cc oxalate	5.8	,,	,,	Half-coag.	5.3
50cc + acid + 10cc oxalate	6.0	,,	,,	,,	5.3
Latex + 1cc oxalate	6.0	Fluid	Fluid	Coagulated	4.9
Latex + 3cc oxalate		,,	,,	Coagulated milky serum	5.3
Latex + 5cc oxalate		,,	,,	Soft coagulum very milky serum	5.3
Latex + 10cc oxalate		,,	,,	Half coagulated	5.4

Bacteria were abundant.

It will be seen from the above Tables that both sulphates and oxalates clearly have an inhibiting action on the immediate thickening of latex by small quantities of acid, while only oxalates inhibited coagulation after 24 hours, corresponding to this sulphates have no buffer action, while oxalates have a marked action in the range dealt with.

It is suggested that the fact that sulphates, which have been shown not to precipitate calcium in the concentration in which it is present in latex do inhibit coagulation materially weakens the evidence of oxalates in favour of enzyme action.

(3) *Barrowcliff's experiment.*

Barrowcliff, and Whitby who confirms his results, have overlooked an important fact in stating that latex dropped into boiling water, no longer coagulates in the ordinary way. It does not *coagulate*, but on standing, or on addition of the usual proportion of dilute acid, it clearly *flocculates*, and separation is so complete that filtration can readily be effected. The filtered portion with slight manipulation between the fingers forms a coherent clot with can be machined. Whitby admits

that creaming, floculation, and coagulation are merely different stages of aggregation, and it can scarcely be argued that the function of the hypothetical enzyme is merely to take separation from the stage of flocculation to that of coagulation. Further considerations are: -

(*a*) Much better aggregation can be obtained from Barrowcliff's fluid if the latex before dropping into boiling water is made slightly alkaline. (Table IV).

(*b*) Small quantites of calcium salts in presence of dilute acid bring about better coagulation than barium salts (Table V.)

(*c*) The writer has been unable to repeat Barrowcliff's result that very small quantities of fresh latex—"a few drops"—brings about normal coagulation, instead appreciable quantities have been necessary. (Table IV)

TABLE IV.

Latex was dropped into boiling water, which was kept boiling, in the proportion of 20 latex : 25 water. After cooling, surface scum was removed. 'Alkali' latex had 10% of its original volume of Normal Na OH added, and after cooling an equal volume of N. HCl.

TABLE IV.

	Normal Latex.			Alkali Latex.
	After 1 hr.	After 20 hrs	After 20 hrs.	After 20 hrs.
	Sample A.		Sample B.	Sample B.
100 ccs — Control	Fluid	Separation, no clot	Separation	Separation
100 ccs + .8ccs N. HCl	Thick	Separation, no clot	,,	Separation, with slight clotting on stirring
100 ccs + 2.0 ccs N. HCl	...	...	Fair clot on stirring	Excellent clot
100 ccs + .5 ccs M. $CaCl_2$	Fluid	Separation, no clot	Separation, no clot	Half coagulated good clot
100 ccs + 1.0 ccs M. $CaCl_2$	Thick	Separation, no clot	Separation, no clot	,,
100 ccs + 3 ccs M. $CaCl_2$	,,	Separation, loose clot	Separation, loose clot	Nearly complete good clot
100 ccs + 1 drop fresh latex	Fluid	Separation, no clot	Separation, no clot	Separation, no clot
100 ccs + .2 ccs fresh latex	,,	Separation, no clot	Separation, no clot	,, ,,
100 ccs + 4 ccs fresh latex	,,	...	Half coagulated	Completely coagulated
100 ccs + 8 ccs fresh latex	,,	Separation, no clot	...	....
100 ccs + 12 ccs fresh latex	,,	Soft clot	Half coagulated	Completely coagulated
100 ccs + 20 ccs fresh latex	,,	Fair clot	Half coagulated	Completely coagulated

TABLE V.

Comparison of action of $Ca\ Cl_2$ and $Ba\ Cl_2$ on boiled latex.

				After 20 hours.
100ccs	+ .2ccs M. $Ca\ Cl_2$		...	Separation, no clot.
,,	+ .4cc ,,		...	,, ,,
,,	+ 1cc ,,		...	,, ,,
,,	+ .2cc M. $Ba\ Cl_2$		...	,, ,,
,,	+ .4 ,, ,,		...	,, ,,
,,	+ 1.0 ,, ,,		...	,, ,,
,,	+ .8 ,, N. H. Cl			
,,	+ .8 ,, ,,	+ .2cc $Ca\ Cl_2$	...	Good Clot.
,,	+ .8 ,, ,,	+ .4 ,, ,,	...	,,
,,	+ .8 ,, ,,	+ 1.0 ,, ,,	...	Perfect clot.
,,	+ .8 ,, ,,	+ 2.0 ,, ,,	...	,,
,,	+ .8 ,, ,,	+ .2 ,, $Ba\ Cl_2$	...	Very loose clot.
,,	+ .8 ,, ,,	+ .4 ,, ,,	...	,,
,,	+ .8 ,, ,,	+ 1.0 ,, ,,	...	Stringy clot.
,,	+ .8 ,, ,,	+ 2.0 ,, ,,	...	Perfect clot.

4. *The gap in acid coagulation.*

This most interesting phenomenon is very strongly suggestive of the existence of an iso-electric point, to be discussed later, while the enzyme hypothesis seems to be put out of court by the existence of an exactly similar gap in latex treated by Barrowcliff's method. Latex was dropped into boiling water as in (3) above.

50ccs + 5cc N/10 HCl—rapid separation no clot.

,, + 3cc N.HCl—remained perfectly fluid, and so remained for 24 hours.

,, + 3cc Strong HCl—Immediate coagulation to good clot.

5. *Slow rate of normal coagulation.*

It is somewhat difficult to follow Whitby's line of argument in view of the very large number of chemical reactions and physical changes taking place at low velocity at ordinary temperature, and accelerated by changing concentration of one of the reacting substances. (a) The acceleration of rate of coagulation by increase of acidity is a perfectly smooth and regular event, (for the low side of the gap), and viscosity determinations show clearly that immediate changes, indicative of incipient coagulation, occur on addition of even very small quantities of acid. Again, after a few hours bacterial action will materially have increased the acidity of the medium, and the added acid can no longer be taken as a measure of acidity.

Table VI shows the viscosity changes referred to :—

TABLE VI.

As De Vries[3] has recently pointed out, the usual Ostwald viscosimeter is useless for latex determinations owing to traces of coagulation occurring. A simple pipette form of instrument was employed, which

could easily be cleaned. Determination were made at air temperature (26-29° C) and for convenience latex diluted with an equal volume of water (D. R. G.-18-20%) was employed. The specific gravity of such latex may for the purpose of this experiment be taken=1. Determinations with water were made at frequent intervals as a check. In all cases determinations were made as rapidly as possible after addition of acid. 50 ccs. was used in every case.

	9.6.23.	11.6.23.	13.6.23.	31.6.23.	20.7.23.
Water	0'.31"	0.32	0'.31"	0.31	0.30
Latex untreated	1'.25"	1.27	1.21	1.18	1.16
50ccs Latex +1cc N/10 HCl	1.30	1.29	1.22	1.23	1.17
,, +2 ,,	1.37	1.31	1.28	1.24	1.35
,, +3 ,,	1.53	1.40	1.13	2.2	—
,, +4 ,,	3.00 coag:	coag:	coag:	coag:	1.59
,, +5 ,,	—				2.31 coag:
50cc Latex +1cc N. HCl		lumpy.			
,, +2 ,,	1.05	1.04			
,, +3 ,,	1.05	1.05			
,, +4 ,,	1.05	1.04			
,, +5 ,,	1.08	1.04			
,, +6 ,,	1.12	1.04			
,, +7 ,,	1.25	1.05			
,, +8 ,,	1.31	1.10			
50cc Latex +1cc N/10 NaOH.				1.00	1.06
,, +2 ,, ,,				0.59	0.59
,, +3 ,, ,,				0.59	0.59
,, +5 ,, ,,				0.56	0.57
,, +1cc N				0.50	0.51
,, +1.5 ,, ,,				0.48	0.55
,, +2.5 ,, ,,				0.50	0.57
,, +3.5 ,, ,,				0.53	0.42
,, +4.5 ,, ,,				0.49	0.58
,, +5.5 ,, ,,					

All determinations were made between 9.00 and 10.00 a.m. At 1 p.m. all except the strong acid and alkaline latices were either coagulated or too thick for measurement. The exceptions gave practically unchanged values.

(5) *Analogy with clotting of milk and blood.*

The evidence brought forward tends decidely to weaken the analogy in question.

General.

In general it is claimed that none of the reasons hitherto brought forward in support of the enzymic theory of coagulation appear to be conclusive when subjected to critical examination; on the other hand a simple theory of bacterial action leading to the production of acid fails to explain all of the observed facts.

There is however, no doubt, that bacteria play some part, direct or indirect, in coagulation. It is possible that they function in one or more of three ways:—

(i) Specific substances may be excreted.

(ii) The protective colloid—protein—may be destroyed.

(iii) Acidity may be developed.

Possibility (i) is negatived by the fact that bacterial decomposition can be allowed to proceed far in latex without coagulation taking place if alkali is added from day to day (in amount sufficient to keep the pH value about 8.5). Judging by the foul smell which develops protein decomposition also is far advanced, but coagulation does not occur, till—either artificially by the addition of acid, or naturally by failure to add sufficient alkali—the acidity rises.*

If this experiment is taken to exclude (i) and (ii) we are left with (iii) viz: – the development of acidity as the sole mode of bacterial action, which leaves no essential difference between natural and artificial coagulation. Hereafter no distinction will be made.

General considerations on Emulsification.

It is known that some heterogeneous systems are extremedly sensitive to even minute quantities of salts while others are undisturbed by the presence of comparatively large quantities of salts of monovalent metals; this formerly led to a distinction between highly sensitive *suspensions* in which the disperse phase was supposed to be solid, and less sensitive *emulsions* in which it was supposed to be liquid. This distinction no longer holds good, and the division is now between *lyophobe* systems in which the affinity of the disperse phase for the dispersion medium is low, and *lyophile* systems in which it is high.

Latex obviously belongs to the latter relatively insensitive class, the reason for this will be discussed later.

Recent work (summarised by Willows and Hatschek,[10] and Lewis[11]) has led to the view that for the continued existence of a heterogenous lyophile system such as latex the following conditions must be fulfilled —

(*a*) The particles of the disperse phase must be between certain limits of size.

(*b*) The particles constituting the disperse phase must be electrically charged.

(*c*) The surface tension of the dispersion medium must be below a certain critical value.

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* It may be of interest to to record that rubber so prepared gives a normal curve on the Schopper machine after vulcanisation, and has a low optimum time of cure.

(*d*) A protective layer must be present around the particles. Such a layer is formed whenever a substance capable of lowering the surface tension of the dispersion medium is dissolved therein.

The presence of such a layer,—almost invariably of a colloid—confers on the protected particles its own electrical properties. As a corollary we have the fact that when the protective body is amphoteric in nature *e.g.* is a protein, the existence of an *iso-electric point* is revealed. This is a point of hydrogen ion concentration at which the electrical charge on particles vanishes or becomes a minimum and at which there is maximum instability.

The electrical charges on particles on either side of the isoelectric point are found to be opposite in sign, being negative on the alkaline and positive on the acid side. From this it may be deduced that on the one side the metallic ions of neutral salts will exert a greater influence on separation, and on the other acid side that the anions will be of greater importance. This deduction is found in practice to be correct.

When the necessary conditions for stability are departed from beyond a limiting value, the stability of the system is destroyed, and separation —precipitation, clotting, clarification, coagulation —ensues.

GENERAL CONSIDERATIONS APPLIED TO LATEX.

In the application of the general theory to latex one limiting consideration must be made clear - physico-chemical work is carried out with pure substances, under controlled conditions, latex is a biological fluid, subject to change, and containing not inconsiderable quantities of salts which *ex hypothese* have marked effects on the system under consideration. Deviation from rule must therefore be expected.

The phenomenon of coalescence of rubber globules as opposed to simple separation presents no theoretical difficulties in the case of a plastic solid (or viscous liquid) such as rubber. Once two particles collide, the interfacial tension will be exerted in the direction which tends to reduce surface energy to a minimum, and this is most easily effected by coalescence with the resultant reduction of surface; it is therefore proposed to consider only the necessary physical conditions for stability and separation.

All the conditions for stability have long been known to exist in fresh latex —the particles are electrically charged, their size is within the given limits, and proteins, among other substances, are present to lower the surface tension of the dispersion medium and to form a protective layer.*

Hydrogen ion concentration.

Since hydrogen ion concentration plays a most important part in the modern theory of heterogeneous mixtures, it is essential to follow as

*It is important to remember that this protective layer, due to absorption is *not* a definite lining membrane, such as Weber claimed to have demonstrated, but is merely an adsorption film.

completely as possible the changes undergone by latex in this respect. Total acidity is apt to be misleading, since owing to different degrees of dissociation, equivalent quantities of a 'weak' acid e.g. acetic and a 'strong' acid e.g. hydrocholoric may produce very different hydrogen ion concentrations in the same solution. For this reason little note was taken of total acidity and the 'strong' acid HCl and 'strong' base Na OH were used in the experiments given below. For convenionce the pH notation has been adopted i,e. the negative logarithm of hydregen ion concentration per litre; on this notation large values mean low acidity, small values high acidity.

The determination of the pH value of latex is not easy, Electrometric methods are difficult and uncertain owing to surface coagulation on the platinised surface of hydrogen electrodes, while colorimetric methods must be very approximate owing to the opacity of the fluid, further, over the range of values from untreated latex to first coagulation point 6.0 to 4.8, no brilliant indicator colour was available. The method finally adopted, that of spotting, was found to give fair agreement with a few electrometric determinations, and results may be relied on to $\pm$.2. The indicators found most useful were thymol blue (both ranges) brom-phenol blue, methyl red, and phenol red. A comparison of the two methods is given in Table VII.

TABLE VII.

	Electrometric. Strong. (36% D.R.C.)	Electrometric. Dilute. (18% D.R.C.)	Colorimetric. (Me red). Dilute. (18% D.R.C.)
Latex untreated	6.2 pH	6.4 pH	6.0 pH
50cc." +.5cc N/10 HCl	6.2 ,,	5.95 ,,	6.0 ,,
,, + 1cc	5.75 ,,	5.8 ,,	5.7 ,,
,, + 2cc	5.55 ,,	5.4 ,,	5.5 ,,
,, + 3cc	5.35 ,,	5.1 ,,	5.2 ,,
,, + 4cc	5.2 ,,	4.9 ,,	5.1 ,,
,, + 5cc	5.1 ,,	4.8 ,,	5.0 ,,
,, + 6cc	—	4.75 ,, coag:	4.9 ,, coag
,, + 9cc	4.9 ,,		
,, + 11cc	4.8 ,, coag:		

A large number of determinations gave a pH range for fresh latex of 5.8 to 6.3; on standing in shallow layers, or on evacuation, this rapidly increased by .2 or .3 pH due to loss of CO_2.

Table VI showed clearly that changes were set up on the immediate addition of acid which resulted in increased viscosity, but for rapid coagulation (in 5-19 minutes) a pH value of 5. 2-4. 9 is necessary.

As the pH value is further decreased by the addition of further quantities of 'strong' acids e.g. HCl, HNO_3, H_2SO_4 coagulation becomes less perfect, and shortly the gap of Whitby is reached and equilibrium is regained; at the same time viscosity is markedly decreased. The quantity of HCl required for equilibrium is 4-6 ccs

N.HCl to 100ccs of dilute (20% D.R.C.) latex, and the pH value is about 2.5. With the addition of still more acid and at a pH beyond the lower limit of thymol blue, coagulation again occurs.

The electric charges on the particles.

V. Henri and others have shown by the method of cataphoresis, that the globules in latex are *negatively* charged, i.e. travel to the positive pole on the application of a potential difference. This has been confirmed by the writer both macro-and microscopically and the additional observation has been made that, within the gap, the particles are *positively* charged i.e. travel to the negative pole. The positive charge however always appears to be smaller that the negative, since the speed of movement of normal globules always exceeds those positively charged.

The action of salts.

A large number of experiments were carried out, which confirmed the results of other workers on ordinary latex, in addition latex within the gap was investigated.

(*a*) Ordinary latex pH. 5.8—6.2. The usual results were obtained; the kation plays the most important part in coagulation and Al in alum and Ca were the most efficient precipitants, followed by Ba, Sr, Co and Mg. K, and Na did not cause separation until added in large quantities, while the addition of .2-1ccs of M. solutions of salts of the metals of higher valencies to 50ccs of half strength latex had marked effects.

An exception to the series was found in the case of $Al\ Cl_3$, which was found to have comparatively feeble coagulating properties, this is doubtless due to the formation of undissociated $Al\ (OH)_3$.

(*b*) Acid latex (p- 1.5-2.2) 50 ccs of dilute (18-20% D.R.C.) latex were used in each experiment, with addition of 3cc N.H Cl. Wherever possible, to avoid undue dilution 2 M. solutions of salts were employed and the results calculated back. In Table VIII results are calculated as number of ccs of M. solutions necessary for coagulation within 10 minutes.

TABLE VIII.

Salt used.	Minimum No. of ccs of M. solution required to coagulate 100cc of acid latex.		
	ccs.	Kation equivalent.	Anion equivalent.
NaCl (2M)	10-12	10-12 ccs.	10-12 ccs.
$Na_2\ SO_4$ (2M)	3-4	6-8	3-4
K Cl (M)	10-12	10-12	10-12
$K_2\ SO_4$ ($\frac{M}{2}$)	3-4	6-8	3-4
Mg Cl. (2M)	4-5	4-5	8-10
$Mg\ SO_4$ (2M)	4-5	4-5	4-5
$Ca\ Cl_2$. (M)	5-6	5-6	10-12
$Ba\ Cl_2$ ($\frac{M}{2}$)	5-6	5-6	10-12
$Al\ Cl_3$ (M)	4-5	4-5	12-15
$AlKSO_4$ ($\frac{M}{2}$)	6-7	6-7 (Al)	6-7
HCl (2M)	20	20	20
H_2SO_4 (2M)	8	16	8

Consideration of these figures shows that the kation is no longer the predominating partner, and that the anion is obviously playing a larger part in precipitation. The kation however, is not absolutely without effect as the highest anion concentration is required for the salts with a cation of the highest valency viz. Al.

Thus along three different lines, viz. viscosity, electric charge and salt effect, and stability we are led to the conclusion that the region of first coagulation is an iso-electric region, while second coagulation is an effect of the anion of the acid employed, which can more readily be brought about by salts.

It is to be noted that instead of a sharply defined iso-electric *point*, there is broad *region* reaching from pH 5 2 to pH 2.2 This blurring is undoubtedly due to the fact mentioned above—that latex is a mixture of many components, including the divalent kations Ca and Mg and the trivalent anion PO_4. Better results could doubtless be obtained after dialysis, but facilities have not, up to the present, being available for dialysis at low temperatures, and preservatives are out of the question.

V. Henri's results on dialysed latex are, as Whitby points out inadmissible, because the specific gravity given by him suggests that the latex used was not that of Hevea.

It is hoped to conduct work on dialysed latex in the future, for the present it suffices to state that latex does undoubtedly show the existence of an isoelectric region.

Surface tension and surface films.

For the same reason that the Ostwald viscosimeter is useless, the capillary tube method of determining surface tension is tedious and unreliable; the drop method was used—in this surface tension is inversely proportional to the number of drops formed. For convenience, the latex used was diluted with an equal volume of water. Table IX gives typical results.

TABLE IX.

Temperature—that of the air = 27°C.

Liquid.		Drop number.
Water	...	31, 31.5, 31
Latex pH 5.9	...	40, 39
Latex in gap	...	38, 39
Serum of above after coagulation with acetic acid	...	34, 34

Many similar results were obtained, showing a considerable rise in surface tension on coagulation, thus here also latex obeys the conditions set forth.

There can be no doubt of the part played by the protein in emulsification since one or more of these bodies or their closely allied

products,* are precipitated at a pH value very close to that of the first coagulation point. As De Vries points out the action of the protein in forming a protective layer—called for by the theory of surface energy also explains why the properties of latex are those of an emulsoid or hyalophilic mixture, and not those of an unstable sol which might be expected of a highly insoluble terpene.

In the same way the protein layer explains the comparatively high pH value at which the isoelectric region starts, instead of the low value (about 2.2) of most resin and gum sols.

Whitby† has recently pointed out that attention should be given to the 'resins' of latex as possible emulsifiers.

It was found that either the "acetone soluble" or "resin-acids," obtained from latex could be induced to form a "sol" with water by solution in alcohol and then pouring into a large excess of water. This solution was not precipitated at pH 4.5 and remained stable till the value of 2.2—2.4 was reached, when separation occurred.

Another series of experiments dealt with sodium 'resinate.'

The 'acetone soluble' or resin acids were dissolved in alkaline alcohol, the addition of water now gave an opalescent solution, which on the cautious addition of acid, started to precipitate at neutrality and was completely precipitated at pH 6.0. This result indicates that resinates could not exist, as such, in normal latex, and it remains to consider the possible emulsifying action of resin as sol.

Here again we meet with the protein complication, the resin particles of the sol, whether microscopic or ultra microscopic will also be coated by protein, and will therefore have identical properties with the caoutchouc globules, and could therefore not assist in emulsification.‡

There remains the possibility pointed out by Whitby that in *alkaline* latex, the resin may be an additional emulsifier Confirmatory evidence has been obtained by surface tension determinations.

TABLE X.

Liquid.		Drop number.
Water	...	31, 31.5
Fresh half-strength latex	...	37—40 (range of many samples).
Fresh latex + 2% NH_3	...	37—38
Latex preserved with 2% NH_3—after 2 months, diluted with an equal volume of 2% Am. Hyreate	...	49—50

* *Vide* accompanying paper on "Some constituents of rubber latex.'.

† The writer has not had the advantage of reading Whitby's full paper on this subject, and the view here adopted may have been put forward in it.

‡ The question of the independent existence of 'resin' in latex is purposely omitted from this discussion—if it is dissolved in the terpene the question of emulsifying action does not arise. In this connection v. Whitby. Plantation Rubber.

This indicates a gradual change which appears most likely to be the slow conversion of resin acids into resinates.

THEORY OF COAGULATION.

It is suggested that all the phenomona of coagulation of normal latex can be accounted for on the theory that the caoutchouc globules in latex have a protective layer of protein, which has an isoelectric region starting at the first coagulation point of normal latex (pH 4.9—5.4).

'Natural' coagulation is held to be due to acidity developed by bacterial action.

Difficulties.

The apparent difficulties to be encountered by this theory are:—

1. Barrowcliff's experiment.

2. Whitby's observation that tannic acids and other protein *precipitants* (as opposed to coagulating agents) produce at first a slimy coagulum.

3, The fact that the latex of very poor yielders or of trees freshly opened frequently coagulates on the tapping cut, without signs of bacterial action or increased acidity.

To deal with these *seriatim*:—

It has been shown above that the first difficulty is more apparent than real, heating produces 'creaming' and flocculation does occur on increasing the acidity of Barrowcliff latex.

It is admitted by Whitby that once partial separation has occurred the next step—to coagulation—is one of difficulty; the larger aggregates may be in equilibrium with the changed conditions of the dispersion medium, and the number of collisions occurring in a given volume and given time is enormously reduced. In fact a large alteration in the system must be made for the small aggregates to coalesce and coagulation proper to follow—such alterations may be brought about by the addition of comparatively large quantities of salts or acids.

There is a possibility in the case of both (1) and (2), viz—that owing either to the previous action of heat, or the action of tannic acid, the protective protein film is *precipitated* as a definite skin (akin to the membrane of Weber) before the globules have time to coalesce in large numbers. Ordinary coagulation of protein is a slower process which proceeds *pari passu* with coalescence of the globules and does not interfere with the latter. The protective action of alkali in Barrowcliff's experiment supports this view, and may be supposed to render the protein less explosively coagulable.

The third objection may also be met, in both poor yielders and virgin trees the proportion of sap from wounded cells is much higher

than in ordinary latex. This sap contains considerable quantities of Ca and Mg salts and also quantities of acid tannins, and it is more than likely that the combination may cause rapid coagulation. Further investigation on this point will be carried out. It is realised with Whitby that experience of work on latex and the remarkable variations met with does not encourage the making of a universal theory to meet every possible case. The theory set out, does it is believed, meet the conditions met with in ordinary plantation practice.

Deductions from Theory.

It is possible to deduce certain facts of interest from the theory advanced and from facts which have long been known and to enquire how far these deductions are fulfilled in practice.

Coagulants.

(*a*) The acids which by reason of their 'weakness' do not raise acidity to pH 5—4 will not cause coagulation, and may retard it if added in sufficient quantity.

(*b*) Any acid which raises the acidity of latex to a pH value of about 5.0 - 5.4 will cause coagulation.

(*c*) Only acids which raise the acidity beyond 2.5 will, in suitable quantity suppress coagulation.

(*d*) Only acids which raise the acidity to a higher value than pH 1.5 (?) or which largely increase the anion concentration will again cause coagulation.

All these deductions are capable of verification.

Boric and hydrocyanic acids retard coagulation, acetic acid never reaches the gap, oxalic acid gets into the gap, but not out of it, while the strong mineral acids satisfy condition (*d*).

It is precisely because acetic acid is moderately weak that it is so well suited to plantation practice, where a 'fool-proof' coagulant is needed. Quantities up to one hundred times the correct amount (2% of 5% giving with half-strength latex pH = 5.4 approximately) give a pH value insufficient to cause damage. Slight excess of the cheaper mineral acids causes a large increase of hydrogen ion concentration, and serious disturbances in the subsequent rate of vulcanization.

If the addition of acid could be carried out under laboratory conditions any acid fulfilling condition (*b*) could be used. This was proved by *titrating* latex with several acids, using methyl red as an indicator and the colour given by acetic acid in standard amount as standard (pH = 5.4).

Quantities used were. Latex 2000ccs D.R.C. = 18%.

Acetic acid	10cc	N. solution—approx, 20cc 5% to 1000	
HCl	10 ,,	N	,,
H_2SO_4	11 ,,	N	,,
Oxalic	17 ,,	M	,,
Nitric	11 ,,	M	,,
Tartaric	12 ,,	M	,,
CCl_3COOH	10 ,,	N	,,
H_3PO_4	18 ,,	(Molar)	

On the following day some of the coagula were softer than others, but on creping drying and vulcanization all gave exactly similar rates of cure and stress-strain curves.

Preservatives.

It is to be deduced that anti-coagulants may act :--

(*a*) By lowering of H˙ concentration—alkalis.

(*b*) By suppression of rise of H˙ concentration--buffers and alkalis.

(*c*) By removal of salts which might assist to bring about coagulation—oxalates.

(*d*) By suppression of bacterial action--formalin.

(*e*) By denaturing of protein, rendering it less easily coagulable--formalin.

(*f*) By lowering of surface tension either:

(i) directly, as saponin.

(ii) indirectly, as alkalis forming resinates.

Also of course there may be a combination of several factors.

It is probable that the most satisfactory preservative will ultimately be found to be a mixture of say—an alkali and antiseptic, and a buffer salt.

A few preliminary laboratory experiments with an alkaline borate mixture gave not unpromising results, but the matter is rather one for a factory trial that for laboratory work.

Any buffer mixture which will keep H˙ concentration below a given value (about pH 5) will delay coagulation, but once bacterial action starts, sooner or later coagulation will occur.

An example of buffering may be seen below.

TABLE XI.

Citrate-phosphate Buffer.

10cc buffer solution and 10cc strong latex.

pH of buffer solution	...	State of mixture after 24 hours.
1.9	...	Coagulation, no gas.
2.9	...	Coagulation, little gas, few bacteria.
3.5-4.7	...	Coagulation, abundant gas, abundant bacteria.
5.0	...	Some gas, imperfect coagulation.
5.4-5.9	...	Small plug of coagulum, remainder fluid abundant bacteria.
6 3	...	Quite fluid, slight smell of putrefaction.

The absence of the gap is undoubtedly due to the high concentration of salts present.

Brown Bast.

It was stated in the introduction that a study of coagulation might throw light on the most puzzling of all rubber problems viz., brown bast.

It is attractive to speculate on possible causes for the coagulation which occurs within diseased bark—there may be

(*a*) Development of acidity.

(*b*) Raising of surface tension, due to reduction of the protein on overtapping.

(*c*) Raising of the Ca salt concentration in the surrounding bark, with eventual diffusion of excess of Ca into the tubes and coagulation.

This last is particularly attractive in view of the (normally) small amount of Ca removed by latex in comparison with Mg and K, and this might lead to accumulation as suggested.

It is proposed to initiate work on these lines.

Summary.

1. The temperature and volume changes on coagulation are investigated, and reasons given for believing that no change of state occurs on coagulation.

2. Previous theories of coagulation are examined and evidence brought forward that the observations made can be differently interpreted.

3. The conditions necessary for equilibrium and for separation of systems such as latex are considered.

4. Latex is shown to satisfy these conditions.

5. The theory is put forward that coagulation is normally due to increase of hydrogen ion concentration, which may be brought about by bacterial action, and that the phenomena met with can be explained by the assumption of an iso-electric region for the protective protein.

6. The resins are shown to be unlikely to function as emulsifiers in normal latex.

7. Certain difficulties are considered, and deductions of practical interest made.

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Received for publication 21*st November*, 1923.

STUDIES ON HEVEA LATEX.

II. SOME CONSTITUENTS OF LATEX.

By W. N. C. Belgrave & R. O. Bishop.

THE work about to be described was the result of an attempt to effect a rough separation of some of the substances in latex with a view to the testing of their effects on the rate of vulcanization of rubber and also as a preliminary survey of possible lines along which more detailed work in the future should proceed. Naturally, final results have not been attained, but it is desired to record the work carried out. The effects of the bodies isolated on vulcanization have been dealt with elsewhere.*

Serum.

When latex is coagulated by the addition of acetic acid a soft open coagulum is formed which subsequently shrinks and toughens. In the first stage the solid holds almost all the liquid and apparently all the gas which exists in the original latex. As a result of the shrinking and toughening of the coagulum the liquid is largely released and can be collected as a clear, practically colourless fluid which is optically active and exhibits a varying laevo-rotation.

On neutralisation with alkali a very distinct change occurs, the neutral point (7.7 pH) being characterised by the development of a deep violet colour which is sufficiently marked to be of use as an indication of neutrality. At the same time a white flocculent precipitate is thrown down. The colour has so far precluded any observations of change of optical rotation in the liquid. The solid can be purified by filtering, washing, solution in dilute acid and reprecipitation. It is found to be a nitrogenous body containing no mineral matter. The nitrogen as estimated by Kjeldahl's method is 12.0%. A diluted acid solution of this substance is not optically active and a precipitate is obtained on heating to 60°C which contains approximately 12% N_2 by Kjeldahl and is not soluble in acid.

A similar precipitate is obtained on heating the original serum to 60°C. On drying it also gives a hard horn-like material which contains no ash and approximately 12% N_2 (Kjeldahl).

A precipitate is obtained on saturation of the serum with Am_2SO_4, but not with Na Cl or Mg SO_4 or on half saturation with Am_2SO_4. The Am_2SO_4 mixture may be taken into a fresh water solution and then by dialysis the sulphate can be separated away. In our work a check on the elimination of the ammonium salt was reckoned to be the complete absence of any precipitate when the dialysate was acidified and tested with Ba Cl_2 solution. The dialysed solution upon

* M.A.J. XI, No. 11, p. 310.

evaporation on a water bath gives a white solid which on drying is tough, horny and greyish in colour. The nitrogen estimated by Kjeldahl is approximately 12% and there is no ash. The substance gives the typical colour reactions of proteins, and identification with such bodies may, following previous workers, safely be made.

Our work indicates that the serum from a 40% D.R.C.* latex contains approximately 0.15% of this protein, the amount being variable.

An investigation on further chemical characteristics of this body, which for future reference is described as the "heat coagulable protein" to decide whether it as a simple or compound protein (the latter being indicated by the low nitrogen content and the nature of its decomposition products has not yet been attempted).

After the heat-coagulable protein has been removed it is found that prolonged heating at an elevated temperature does not have any further effect on the optical rotation of the liquor. There is no precipitation and no material change in colour, either in acid or neutral solution. We are not convinced however, that all the soluble constituents of the serum liquor remain free from change.

If the liquor (either acid or neutral) is poured into 96% alcohol a white flocculent precipitate is obtained. This on washing and drying is found to be approximately 0.05% of the original latex. The same precipitate is formed from acid or neutral serum which has been subjected to decomposition under aerobic and anaerobic conditions.

The precipitation appears to be due to a coagulation inasmuch as the body cannot be redissolved in the original liquor. It is almost insoluble in water and can be washed free from salts and sugars. Drying in the air causes rapid darkening, drying in vacuo produces a tough horny substance greyish in colour which is found to contain N, Mg, K, P_2O_5. Nitrogen estimated by Kjeldahl is approximately 8.0%. Total mineral matter by incineration is approximately 13.0.

On heating alone in the air the substance decomposes, evolves ammonia and then gases with a strong pynol reaction, and fairly dense brown fumes.

It has not been possible directly to establish the optical activity of this alcohol coagulable body but it is found that after its removal the serum liquid residue exhibits a large reduction in optical rotation although of the same direction as originally determined.

Attempts were made to remove some of the mineral matter of this body by dialysis; for this purpose the original serum liquor remaining after the heat coagulable protein had been separated was subjected to dialysis into running water for several days, after which the alcohol coagulation carried out as usual. The body obtained showed the same percentage of nitrogen (by Kjeldahl) and ash as

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* D.R.C. Dry rubber content. Estimated by coagulating with acetic acid.

before, suggesting that the components were combined, or in very close association.

RUBBER.

In order to obtain information on the protein associated with coagulated rubber, attempts were made to wash it out of recently coagulated rubber by using water, dilute acid, alkaline and neutral salt solutions.

All attempts at removing appreciable quantities of protein-like bodies from rubber failed, even when the rubber was prepared in exceptionally thin films by spreading latex on filter paper, or by mixing with a large excess of sand and subsequent grinding; similarly it proved impossible to remove suspended, or adsorbed matter from benzene solutions by any mechanical process.

Another method tried was that of mixing dilute latex with ether, and shaking vigorously—when a thick translucent liquid and a clear aqueous solution is obtained—still no effective separation was obtained.

Lastly, the method of Spence and Kratz* was adopted—viz. depolymerisation of an acid benzol solution of rubber by sunlight. A 10% solution of rubber in benzol with .5% trichloracetic acid was employed. After a few days exposure, the previously highly viscous solution became more limpid and eventually (after several days) separated into a perfectly clear golden-yellow solution and a flaky brown sediment. After decantation, this sediment was exposed with fresh acid benzol, then given several washings with benzol, filtered and dried to a brown, somewhat horny mass, which was treated as in Table I.

* v. Whitby Plantation Rubber p. 117.

TABLE I.

The mass was ground, digested with cold water, then filtered.

Filtrate.	Residue. Extracted overnight with cold 1% Na OH, then filtered.			
	Filtrate.		Residue.	
	Yellow solution giving a copious precipitate with dilute HCl. This was filtered.		Extracted for 1 hour with 1% aqueous Na OH at 60°C then filtered.	
	Filtrate.	Precipitate.	Filtrate.	Residue.
Strongly acid. No precipitate on neutralisation or on making alkaline. On evaporation to dryness a pale yellow residue was left, which heated with soda-lime gave copious alkaline vapours and a strong pyrrol reaction. On ashing, there was a copious residue, which reacted for K, Mg, & P_2O_5.	Evaporated to dryness gave a small residue of sodium chloride.	Washed with fainty acid water. Dissolved in dilute alkali reprecipitated with acid and again washed, on evaporation brown resinous flakes were obtained, which on heating with soda-lime gave copious alkaline vapours, and a brilliant pyrrol reaction. On ashing only a negligible residue is left. The substance is entirely soluble in cold alcohol (96%) to a brown solution with marked fluoresence.	Yellow brown colour and apparently identical with the filtrate from the cold extraction.	Very small in amount—burns with a strong smell of rubber—leaving no appreciable ash—and giving traces only of nitrogenous bodies when heated with soda-lime.

The very surprising solubility in alcohol of the supposed protein precludes the idea that the substance obtained by us on depolymerisation was unchanged protein -- it leaves open the question of derivation. Does the separation of a nitrogenous material* with much ash soluble in water irrespective of reaction from the ashless body soluble only in alkaline solution represent an original separation, or are they both breakdown products of a parent body—the splitting being due to prolonged insolation ? The problem cannot be answered at this stage.

It may be of interest to note that the benzol rubber solution on evaporation left a sticky brown residue which had an N content (by Kjeldahl) of only .07%. After standing in bright diffuse light in an open beaker for 2 —3 months this residue became tough and moderately elastic and was clear brown in colour. It vulcanized with marked rapidity and the character of the curve obtained on the Schopper machine was normal.

ALCOHOLIC MOTHER LIQUORS.

Attention was next turned to the alcoholic liquors —as described elsewhere the alcohol was 'acid' pH *c.* 3 and 'neutral' pH *c.* 7.4 and 'alkaline' = *c.* 9.0.

The solutions were filtered to remove traces of suspended rubber and were faintly yellow in colour They were then distilled to remove most of the alcohol, becoming turbid in the process, and at the same time turning pale green in the case of 'acid' or 'neutral' solutions, pale red-brown when 'alkaline.' They were further concentrated on a water-bath, with a progressive separation of waxy-looking matter which in acid or neutral solution, lumps together and may be readily removed by filtration. In alkaline solution —lumping does not occur, and filtration is almost impossible, except after addition of acid, -it is hoped shortly to effect separation in alkaline solution by the use of a high speed centrifuge.

Waxy solids insoluble in water.

The waxy solid obtained by such treatment is now only partially soluble in alcohol, suggesting that heating to 90°C has caused decomposition, this residue was further treated as follows : --

Solid extracted with acetone.

Solution.

Yellow brown, giving on evaporation a dark brown waxy mass - called herewith "acetone-soluble."

Residue. Extracted with hot chloroform.

Solution.

Bright yellow giving yellow waxy mass on evaporation called "lecithin-body."

Residue.

Light brown friable solid, insoluble in water or alcohol called "insoluble."

* M.A.J. XI, p. 11.

Acetone soluble.

Is entirely soluble in alcohol, and if this solution is poured into excess of water, a very slightly opalescent liquid of lowered surface tension is obtained. On addition of acid or of salts of alkaline earth metals a white precipitate is thrown down. The original material is soluble in hot aqueous alkali, on addition of acid a yellow white non-N precipitate is obtained; the solution on heating with strong alkalies evolves NH_3. On evaporation and heating with soda lime no pyrrol reaction is obtained. A negligible residue is left on ashing.

After saponification with alcoholic potash in the usual way the unsaponifiable residue gave strongly marked cholesterol reactions and is undoubtly composed of the plant alcohols described by Whitby.

The residue is partly composed of acid bodies (resin acids) and partly of sugar and nitrogenous bodies.

Lecithin-body.

From the method of preparation, is obviously insoluble in acetone, is easily soluble in alcohol, and also forms an opalescent solution on pouring the latter into water—from which it is precipitated by acid.

On heating with caustic soda solution or soda-lime copious alkaline vapour with a strong fishy smell are evolved—no pyrrol reaction is given. On ashing, a residue is left which gives a strong reaction for phosphate.

In alcoholic solution a crystalline precipitate is obtained with cadmium chloride. It seems safe to assume that this body is akin to "lecithin."

Insoluble.

The fact that this body is produced by heating was confirmed by conducting the evaporation of the original alcoholic liquor in vacuo at a temperature not exceeding 45°C. Separation of the waxy bodies took place but these was entirely soluble in alcohol, and practically ashless.

The only one of the usual colour tests for N bolies given by the "insoluble" was the zanthoproteic; murexide, Millon and biuret were negative.

On heating alone or with soda lime gives some alkaline vapours and a brilliant pyrrol reaction. On ashing the residue consists almost entirely of magnesium phosphate. The amounts of the three bodies obtained by dropping 1000 ccs latex (40% dry rubber) into 3000 ccs warm neutral alcohol, with their N and ash content are given below.

	Acetone soluble.	Lecithin-body.	Insoluble.
Grams	3.6	2.0	0 9
N % (K)	.9%	1.2%	10%
Ash	trace	6.5%	8%

It will be noted that the "insoluble" from alcohol contained more N and less ash than that from serum. More detailed analytical work will to carried out in the future. It is suggested that both "insolubles" represent some form of humin break-down product, combined with, or very closely adsorbing mineral constituents.

Water-soluble.

On evaporation and ashing, the water soluble residue after removal of the waxy bodies gave Mg, K, traces of Ca, and P_2O_5. On heating alone, alkaline vapours and the pyrrol reaction were obtained and these were increased by heating with soda lime.

The water soluble portion on evaporation gave non-N crystals in a brown sticky matrix and all attempts at an effective separation of nitrogen bodies from the matrix failed. Lead acetate, phosphotungstate, mercuric chloride and similar reagents, give precipitates which on heating with soda lime evolved alkaline vapours but gave no pyrrol reaction.

These precipitates are probably from decomposed protein products but the residue after precipitation with those and other precipitants invariable gives a strong pyrrol reaction and the reacting body is obviously dissolved in the brown uncrystallible mother liquer. On account of the possible theoretical importance of pyrrol-ring bodies in the synthesis of caoutchouc prolonged but fruitless attempt were made to separate such bodies by extraction with the usual organic and other solvents from acid and alkaline residues. This elusiveness suggests the possibility that the pyrrol test obtained is due only to a secondary reaction between ammonium salts or amines and laevulinic aldehyde present in the residue; the latter body being a well known decomposition product of oxidised caoutchouc—apart from the possibility of formation from carbohydrate.

The alcoholic solution was was accordingly tested for laevulin -aldehyde with negative results.

To sum up, in latex there appears to be N in the form of protein bodies, lower diffusible products thereof and lecithin-like bodies. The intensity of the pyrrol reaction almost always obtained, the solubility in alcohol of products giving it, and the low percentage of N invariably obtained in separated products, suggest that the proteins in latex are not of the usual type. Further experiments are in hand with a view to better methods of protein extraction.

Nitrogen determinations on latex and rubber.

The uncertainty of the form in which N occurs in latex suggests that Kjeldahl's method should not be relied on as a measure of the total N. in latex or rubber and a series of determinations by Dumas' method were accordingly carried out.

Preliminary determinations with a commercial sample of acetanilide gave good agreement between the two methods.

		Dumas nitrogen %	Kjeldahl nitrogen %
Acetanilide	-	12.0	12.05
Latex sample A	-	0.76	.26
„ B	-	0.68	.25 & .25
„ C	-	0.72	.36
„ D	-	0.80	—

The estimation is not without difficulty, and owing to the large carbon and small nitrogen content of latex it is inadvisable to mix the latter with fine CuO as reduction once started is apt to be violent, and in one case led to a minature explosion.

The agreement of the Dumas results above is so good, considering the varying nature of the product that it was considered to be proved that far more N is present in latex than is shown by Kjeldahl. Estimations were then carried out on fresh crepe, and gave results varying from .76 to 1.2% of N against the Kjeldahl figure of .25%. Again the agreement of the Dumas' results seemed within expectation. As a final test, eudiometric examination of the evolved gas were carried out, and in every case, with rubber, an explosion followed on sparking with O i.e. reduction had been incomplete. So far no modifications of the apparatus using CuO has given non-explosive gas. It is hoped to get better results with some of the newer Pt contact methods, until this has been done no reliance can be placed on any of the Dumas' results given above even though in all comos the contraction following explosion was very small. Unfortunately, no test was made with the gas from latex, so for the present these results also must be discarded.

Inosite-bodies.

Several previous workers have recorded the presence of l-meinosite in latex. This was confirmed by the writers, who have however, so far, failed to obtain the characteristic colour reaction of inosite with the methyl compound. This reaction however, is known to be very easily upset by trace of impurities; or possibly, by methylation.

It is of interest to note that the observation recorded above that there is a loss of rotation of serum after removal of an 'insoluble' body invalidates Gorter's* method of estimating l-me inosite in serum by determination of rotation.

SUMMARY.

An account is given of the separation of: —

(1) Serum protein on neutralisation.
(2) an alcohol-insoluble nitrogenous body from serum.
(3) different constituents of the 'depolymerised residue.
(4) waxy bodies—phytosterols, resin acids and a lecithin—like body from alcoholic liquors.

* v. Whitby Plantation Rubber p. 62.

Reasons are given for thinking that some of the supposed proteins separated are either break-down products or are different in composition from proteins normally met with.

Unsuccessful attempts at Dumas estimation are described.

Received for publication 20th November, 1923.

NOTE.

PASSIFLORA.

The Department of Agriculture, S.S. and F.M.S. is now in a position to supply a limited number of plants of *Passiflora edulis*, *Passiflora quadrangularis* and *Passiflora laurifolia*.

Application should be made to the Agriculturist, Department of Agriculture, S.S. and F.M.S.

CENTROSEMA.

The Department of Agriculture, S.S. and F.M.S. has reduced the price of *Centrosema Plumieri* seed from 11 cents per lb. to 8 cents per lb.

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Abstract of Meteorological Readings in the various Districts of Malaya for the Month of January, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	142.0	78.4	83.93	72.51	11.41	74.0	.756	70.9	77.	...	12.16	2.48
Pahang, Kuala Lipis	...	...	77.9	84.4	69.1	15.3	74.5	...	...	...	...	13.27	2.50
Johore, Johore Bahru	...	..	...	83.84	71.74	...	...	...	...	...	...	11.90	3.55
Singapore, Kandang Kerbau	1015.0	...	79.2	84.6	73.8	...	76.1	.872	...	85.	Calm	15.79	6.92
Malacca, Durian Daun	1017.6	113.	80.	87.	72.	15.	77.	.885	...	83.	N.	8.89	1.73
Negri Sembilan, Seramban	...	140.16	79.65	90.	72.92	17.08	76.18	.835	73.84	82.65	S.W.	5.09	1.02
,, Kuala Pilah	...	134.87	78.33	83.26	69.81	13.45	75.83	.841	74.04	87.19	...	7.61	2.13
,, Port Dickson	...	144.8	79.16	86.1	73.03	13.07	75.99	.836	73.8	83.9	...	8.88	2.12
Selangor, Kuala Lumpur	...	151.7	79.7	85.6	71.9	13.7	76.6	.796	72.7	79.	S. E,	10.04	2.00
,, Klang	...	...	78.2	83.4	75.4	8.0	75.4	...	...	...	...	16.32	2.73
,, Kuala Selangor	...	...	...	89.7	69.6	20.1	...	...	...	...	...	5.57	1.57
,, Rawang	...	...	..	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	79.14	90.	...	...	76.43	.870	...	87.	...	12.16	3.74
,, Ipoh	...	...	79.84	94.	69.	25.	75.09	.807	73.10	80.	...	11.37	2.59
,, Taiping	...	...	79.14	91.	69.	22.	75.56	.837	...	84.	...	16.61	3.14
,, The Cottage	...	...	...	...	...	..	...	...	...	...	...	39.80	4.68
,, Parit Buntar	...	...	81.27	92.	70.	22.	76.90	.869	...	82.	...	5.70	1.10
Penang, George Town	1009.4	153.	79.6	94.	68.	26.	74.7	.860	71.2	85.1	N.	4.99	1.92
Kedah, Alor Star	...	...	...	...	..	...	...	...	...	...	...	1.78	1.20
Perlis, Kangar	...	...	...	84.80	70.96	13.84	...	...	...		...	1.50	.93

*Abstract of Meteorological Readings in the various Districts of Malaya for the **Month** of February, 1923.*

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	TEMPERATURE. Mean Dry Bulb.	Maximum.	Minimum.	Range.	HYGROMETER. Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	143.52	79.8	87.89	70.03	17.85	73.7	.721	69.5	70.	...	.13	.10
Pahang, Kuala Lipis	...	...	80.6	88.0	69.6	18.4	75.1	...	...	...	...	11.94	7.18
Johore, Johore Bahru	...	...	...	88.86	71.66	...	...	...	...	...	...	4.02	1.23
Singapore, Kandang Kerbau	1015.4	...	82.3	88.8	72.7	...	76.9	.892	...	74.	N.	1.85	1.24
Malacca, Durian Daun	1017.5	124.	82.	89.	73.	16.	77.	.890	...	80.	N.	2.12	1.45
Negri Sembilan, Seremban	...	149.9	79.8	90.3	72.4	17.9	76.3	.836	73.3	82.	N.	1.92	.66
„ Kuala Pilah	...	153.2	80.9	88.2	70.3	17.9	76.6	.837	73.8	50.2	...	3.37	1.14
„ Port Dickson	...	162.2	82.5	88.5	73.9	14.6	77.3	.841	71.9	75.7	...	1.82	1.87
Selangor. Kuala Lumpur	...	152.2	82.2	89.9	71.7	18.1	76.2	.804	72.2	73.	N.W.	7.50	2.75
„ Klang	...	...	80.8	86.3	78.4	7.9	76.3	...	...	...	...	2.89	1.20
„ Kuala Selangor	...	...	...	90.	66.2	23.8	...	...	...	...	...	.56	.37
„ Rawang	...	...	...	..	...	..	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	81.31	91.	74.	17.	77.21	.880	...	83.	...	4.88	2.04
„ Ipoh	...	...	81.86	95.	66.	29.	75.64	.805	73.04	74.	...	6.57	2.16
„ Taiping	...	.	81.13	92.	69.	23.	76.38	.845	...	80.	...	10.82	2.50
„ The Cottage	...	...	...	...	...	...	...	...	...	...	..	19.01	3.66
„ Parit Buntar	...	...	80 99	92.	70.	22.	77.4	.894	...	85.	...	3.11	1.37
Penang, George Town	1009.5	154.	78.6	93.	70.	23.	76.5	.868	71.	85.1	N.W.	2.59	1.69
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	.74	.74
Perlis, Kangar	...	...	...	90.53	73.35	20.18	...	...	...	...	...	1.67	1.55

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Abstract of Meteorological Readings in the various Districts of Malaya for the Month of March, 1923.

District	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	144.65	80.6	88.67	72.68	16.19	74.8	.756	70.9	72.	...	11.27	4.97
Pahang, Kuala Lipis	...	...	81.4	90.3	69.3	21.0	75.3	...	...	...	...	3.	.57
Johore, Johore Bahru	...	...	...	89.2	72.19	...	...	...	...	...	...	10.76	1.90
Singapore, Kandang Kerbau													
Malacca, Durian Daun	1017.8	132.	84.	90.	72.	18.	78.	.900	...	76.	N.	5.15	1.02
Negri Sembilan, Seremban	...	148.7	80.	91.06	72.3	18.76	76.7	.852	74.4	83.4	N.W.	7.62	1.57
,, Kuala Pilah	...	151.6	87.3	89.9	69.84	20.06	77.4	.859	74.5	80.1	...	12.62	3.26
,, Port Dickson	...	163.7	88.3	89.1	73.9	15.2	77.4	.829	76.8	72.5	...	3.84	1.73
Selangor. Kuala Lumpur	...	150.1	82.1	90.7	71.8	18.9	76.3	.794	72.1	72.	S.W.	11.06	2.96
,, Klang	...	...	81.	86.1	77.	9.1	76.5	...	...	...	...	7.63	2.37
,, Kuala Selangor	...	...	...	91.	64.6	26.4	...	...	...	...	...	6.	3.07
,, Rawang	...	...	...	..	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	82.47	93.	69.	24.	78.23	.910	...	83.	...	5.11	2.79
,, Ipoh	...	...	82.52	96.	66.	30.	75.29	.779	73.93	71.	...	7.63	2.44
,, Taiping	...	.	81.12	95.	68.	27.	76.32	.844	...	80.	...	13.11	2.91
,, The Cottage	...	...	...	...	...	...	...	...	...	...	..	30.47	6.57
,, Parit Buntar	...	...	82.43	93.	70.	23.	76.93	.852	...	77.	...	4.33	1.02
Penang, George Town	1008.9	152.	81.9	95.	67.	36.	79.4	.949	70.5	84.6	N.W.	6.12	2.59
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	5.38	2.70
Perlis, Kangar	...	...	...	91.22	71.84	19.38	...	...	...	...	...	1.62	.35

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of April, 1923.

District	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	147.26	83.	90.53	74.36	16.16	77.	812.	73.	72.	...	5.69	2.06
Pahang, Kuala Lipis	...	...	82.5	91.4	71.1	20.3	77.2	...	...	...	...	4.75	.96
Johore, Johore Bahru	...	..	...	90.56	74.10	...	...	...	...	...	...	10.24	1.60
Singapore, Kandang Kerbau	1013.4	...	83.8	89.7	75.	...	78.66	.814	...	80.66	Calm	3.19	1.69
Malacca, Durian Daun	1018.2	140.	83.	90.	73.	17.	79.	.921	...	79.	N.	13.5	2.5
Negri Sembilan, Seremban	...	150.4	80.5	91.9	73.2	18.7	77.2	.865	74.8	82.9	...	6.67	1.22
,, Kuala Pilah	...	151.9	82.7	90.7	71.5	19.2	78.5	.892	75.7	81.1	...	8.04	2.75
,, Port Dickson	...	163.3	84.1	89.4	75.4	14.	77.6	.877	75.2	75.5	...	6.61	1.86
Selangor. Kuala Lumpur	...	151.7	82.1	90.8	73.9	16.9	77.1	.838	73.8	77.4	N.E.	10.81	3.17
,, Klang	...	...	81.3	87.1	...	...	77.5	...	...	...	...	11.85	2.23
,, Kuala Selangor	...	...	...	91.3	...	...	...	...	...	...	...	6.06	1.97
,, Rawang													
Perak, Teluk Anson	...	...	83.19	...	69.	25.	79.47	.955	...	85.	...	10.67	3.67
,, Ipoh	...	...	81.80	94.	70.	25.	77.18	.870	74.62	81.	...	12.83	1.97
,, Taiping	...	.	81.20	90.	72.	21.	77.14	.878	...	83.	...	21.26	6.85
,, The Cottage	...	...	..	93.	...	...	.	...	...	...	..	39.39	5.74
,, Parit Buntar	..	...	82.71	94.	70.	24.	77.77	.885	...	81.	...	9.29	1.41
Penang, George Town	1008.7	152.	84.8	92.	70.	22.	79.9	.934	70.6	78.7	...	4.68	1.06
Kedah, Alor Star	...	...		...		...	...	...	...	...	...	10.90	2.35
Perlis, Kangar	...	...	...	91.33	73.73	17.60	...	...	...	...	...	.30	.04

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of May, 1923.

District	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	145.38	83.1	91.80	75.00	16.80	76.9	.807	72.8	71.	...	4.56	.78
Pahang, Kuala Lipis	...	...	81.8	90.5	70.8	19.7	76.7	...	...	...	...	6.39	1.33
Johore, Johore Bahru	...	...	...	89.48	74.06	...	...	...	...	...	...	7.18	1.2
Singapore, Kandang Kerbau													
Malacca, Durian Daun	1018.4	132.	82.	89.	73.	16.	78.	.896	...	80.	N.W.	10.51	2.08
Negri Sembilan, Seremban	...	152.9	81.7	91.2	73.1	18.1	77.7	.903	74.5	79.8	N.W.	3.78	.98
,, Kuala Pilah	...	152.7	82.6	90.6	70.9	19.7	78.6	.908	76.1	81.3	...	10.98	.2
,, Port Dickson	...	162.3	83.9	89.8	75.4	14.4	77.8	.876	75.5	76.2	...	4.36	1.03
Selangor. Kuala Lumpur	...	148.6	82.2	90.2	73.3	16.9	77.2	.840	73.9	79.	N.W.	5.09	1.45
,, Klang	...	...	81.4	86.4	75.	11.4	77.2	...	...	...	...	3.79	1.31
,, Kuala Selangor	...	...	...	90.4	...	...	...	...	...	...	...	3.68	2.2
,, Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	83.17	92.	71.	21.	79.27	.947	...	85.	...	2.73	.9
,, Ipoh	...	...	81.70	94.	70.	24.	77.25	.877	74.77	83.	...	4.37	1.61
,, Taiping	...	.	81.87	93.	71.	22.	77.27	.873	...	81.	...	6.57	2.24
,, The Cottage	...	...	...	...	...	...	...	...	...	...	..	76.04	25.63
,, Parit Buntar	...	...	83.71	94.	72.	22.	78.54	.907	...	79.	...	4.84	1.54
Penang, George Town	1008.8	152.	83.1	94.	70.	24.	79.4	.951	70.5	84.	N.W.	17.75	3.7
Kedah, Alor Star	...	...	...	...	.	...	...	...	...	...	...	12.85	2.64
Perlis, Kangar	...	...	...	90.32	74.48	31.15	...	...	...	...	...	.27	.07

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of June, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	142.05	83.4	91.03	75.40	15.63	74.1	.682	67.9	59.	...	8.90	2.18
Pahang, Kuala Lipis	...	...	81.5	90.6	71.5	19.1	77.0	...	...	...	...	5.63	1.78
Johore, Johore Bahru	...	...	...	87.93	73.80	...	...	...	...	...	...	6.63	2.76
Singapore, Kandang Kerbau	1014.	...	83.83	89.1	75.6	...	81.3	.743	...	82.66	Calm.	4.32	1.17
Malacca, Durian Daun	1018.4	131.	82.	89.	72.	17.	78.	.923	...	81.	N.W.	3.58	.86
Negri Sembilan, Seremban	...	150 2	80.5	90.2	72.7	17.5	77.6	.883	75.5	84.5	N.W.	3.03	.78
„ Kuala Pilah	...	147.9	79.6	90.4	70.5	19.9	78.6	.904	76.1	81.8	...	2.79	1.3
„ Port Dickson	...	157.3	82.9	88.3	74.7	13.6	78.6	.891	75.7	79.3	...	10.53	1.54
Selangor, Kuala Lumpur	...	129.2	82 5	89.6	73.1	16.5	77.5	.847	74.1	76.	N.W.	5.18	2.95
„ Klang	...	...	81.7	85.5	75.2	11.3	77.4	...	...	...	...	9.55	3.03
„ Kuala Selangor	...	...	...	90.1	...	...	...	...	...	...	...	5.53	1.56
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	83.58	93.	71.	23.	79.31	.945	...	83.	...	1.77	.51
„ Ipoh	...	...	83.60	95.	70.	25.	76.38	.811	75 66	71.	...	5.08	2.2
„ Taiping	...	.	83.36	95.	70.	25.	77.92	.885	...	79.	...	1.14	.04
„ The Cottage	...	...	...	...	...	...	...	...	...	...	..	6.26	5.87
„ Parit Buntar	...	...	83.04	93.	72.	21.	77.96	.889	...	79.	...	6.72	4.68
Penang, George Town	1008.9	152.	81.9	93.	70.	23.	78.9	.950	71.3	80.7	S.	14.45	5.27
Kedah, Alor Star	...	...	...	...	..	...	...	...	...	...	...	6.21	1.63
Perlis, Kangar	...	...	...	89.80	75.57	14.23	...	...	...	...	...	.19	.03

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of July, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	145.56	82.8	89.96	73.74	16.22	76.1	.785	72.	71.	...	5.45	1.69
Pahang, Kuala Lipis	...	...	81.2	89.9	69.4	20.5	76.3	...	...	...	...	2.01	.65
Johore, Johore Bahru	...	..	...	86.80	73.16	...	...	...	...	...	...	7.37	3.24
Singapore, Kandang Kerbau													
Malacca, Durian Daun	1018.3	131.	82.	89.	72.	17.	78.	.915	...	82.	N.W.	5.63	2.51
Negri Sembilan, Seramban	...	152.	80.5	91.5	72.7	18.8	77.2	.869	74.9	83.4	N.W.	5.38	2.38
,, Kuala Pilah	...	144.8	81.4	89.2	69.7	19.5	77.6	.875	75.2	82.1	...	3.64	.78
,, Port Dickson	...	153.5	82.3	87.8	73.9	13.9	77.9	.860	75.8	82.5	...	8.14	1.97
Selangor, Kuala Lumpur	...	126.5	82.3	89.5	72.3	17.2	77.2	.838	73.7	75.	N.W.	2.22	1.06
,, Klang	...	...	84.7	86.3	74.6	11.7	76.6	...	...	...	...	1.54	.62
,, Kuala Selangor	...	...	...	89.9	...	...	...	...	...	...	...	4.72	1.53
,, Rawang	...	...	..	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	82.59	93.	70.	23.	78.30	.913	...	83.	...	1.02	.39
,, Ipoh	...	...	81.58	94.	68.	26.	75.99	.822	74.79	76.	...	2.24	1.3
,, Taiping	...	...	82.28	93.	70.	23.	76.95	.855	...	78.	...	4.33	2.71
,, The Cottage	...	...	...	...	...	...	...	...	...	...	...	13.94	3.9
,, Parit Buntar	...	...	82.54	92.	70.	22.	78.40	.917	...	83.	...	4.17	1.92
Penang, George Town	1008.3	148.	82.8	92.	69.	23.	79.2	948.4	74.1	84.8	N.W.	5.78	1.29
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	5.66	1.45
Perlis, Kangar	...	...	...	87.70	73.51	14.19	...	...	...	...	...	.38	.08

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of August, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature. Mean Dry Bulb.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Range.	Hygrometer. Mean Wet Bulb.	Hygrometer. Vapour Tension.	Hygrometer. Dew Point.	Hygrometer. Humidity.	Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
Kelantan, Kota Bahru	...	145 60	82.3	91.25	73.25	18.	75.9	.774	71.6	70.	...	10.03	2.13
Pahang, Kuala Lipis	...	...	80.	90 2	69.2	20.9	76.	...	...	..	...	5.97	1.24
Johore, Johore Bahru	...	..	...	86.51	72 93	...	...	...	...	...	...	6.39	1.26
Singapore, Kandang Kerbau													
Malacca, Durian Daun	1018.2	130.	82.	89.	72.	17.	79.	929	...	83.	N.W.	7.08	1 34
Negri Sembilan, Seramban	...	149.3	80.2	90.4	72.8	17.6	76.9	.858	74.7	83.3	N.W.	6.33	1.48
„ Kuala Pilah	...	146.2	80.8	88.	69.5	18.5	77.07	.884	75.06	85.2	...	8.67	1.38
„ Port Dickson	...	152.3	81.3	87.4	73.7	13.7	77.4	.883	74.9	80.4	...	5.83	1.34
Selangor, Kuala Lumpur	...	150.2	81.2	88.5	71.4	17.1	76.5	.839	72.9	79.	N.W.	8.01	1.57
„ Klang	...	...	79.7	84.7	73 3	11.4	75.4	...	...	...	...	8.38	2.01
„ Kuala Selangor	...	...	...	89.	...	...	...	...	...	...	...	2.42	.63
„ Rawang	...	...	..	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	82.51	93.	69.	24.	79.09	.948	...	87.	...	6.46	1.69
„ Ipoh	...	...	82.61	95.	67.	28.	76.09	.811	73.93	73.	...	2.64	.82
„ Taiping	...	...	83.49	94.	71.	23.	77.45	.860	...	75.	...	9.25	2.83
„ The Cottage	...	...	...	...	...	..	...	...	...	..	...	7.91	1.97
„ Parit Buntar	...	...	83.27	92.	70.	22.	77.68	.873	...	77.	...	5.00	2.08
Penang, George Town	1008.9	150.	82.8	92.	69.	23.	80.4	1.007	71.1	89.3	N.E.	9.76	1.65
Kedah, Alor Star	..	...	...	...	.	...	...	...	...	...	...	4.47	1.9
Perlis, Kangar	...	...	...	88.32	74.48	13 84	...	...	...	...	...	2.19	.32

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of September, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	145.72	81.6	90.4	73.5	16.9	75.6	.772	71.5	71.	...	9.09	2.44
Pahang, Kuala Lipis	...	...	81.1	89.4	69.5	19.9	70.3	...	...	...	...	8.11	1.63
Johore, Johore Bahru	...	..	...	86.60	73.36	...	...	...	...	...	...	7.20	1.60
Singapore, Kandang Kerbau	1014.3	...	83.1	84.6	75.	...	78.	.776	...	80.	S.	5.3	2.59
Malacca, Durian Daun	1018.1	132.	82.	89.	72.	17.	78.	.937	...	85.	N.W.	10.11	2.08
Negri Sembilan, Seramban	...	151.6	80.4	91.4	71.8	19.6	76.7	.854	74.4	83.6	N.W.	5.28	1.47
,, **Kuala Pilah**	..	148.6	81.2	89.1	70.7	18.4	77.4	.868	74.9	81.9	...	2.74	.83
,, **Port Dickson**	...	153.8	81.6	87.3	73.7	13.6	77.7	.872	75.1	80.8	...	7.45	1.14
Selangor, Kuala Lumpur	...	158.1	81.5	88.8	72.6	16.2	76.8	.827	73.8	77.	N.W.	5.04	7.8
,, **Klang**	...	...	80.4	85.5	74.5	11.	76.2	...	...	...	...	5.11	2.3
,, **Kuala Selangor**	...	...	...	89.3	...	...	...	...	...	...	...	6.45	2.54
,, **Rawang**	...	...	..	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	81.68	92.	67.	25.	77.38	.881	...	83.	...	6.10	1.18
,, Ipoh	...	...	80.89	94.	68.	26.	76.09	.835	73.87	80.	...	10.75	3.23
,, Taiping	...	...	81.37	92.	72.	20.	77.02	.872	...	83.	...	15.59	2.20
,, The Cottage	...	...	...	...	...	..	...	...	...	...	...	23.03	2.60
,, Parit Buntar	...	...	82.41	92.	70.	22.	77.67	.884	...	81.	...	15.63	4.96
Penang, George Town	1010.29	159.	81.4	92.	69.	23.	78.5	.940	71.2	87.9	N.W.	22.05	6.65
Kedah, Alor Star	...	...	...	...	..	...	...	...	...	...	...	16.17	2.32
Perlis, Kangar	...	...	...	86.36	73.53	12.83	...	...	...	...	...	.66	.18

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of October, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	141.11	81.3	89.74	74.16	15.58	75.7	.782	71.9	73.	...	9.91	1.43
Pahang, Kuala Lipis	...	...	80.5	89.2	69.6	19.6	76.1	...	...	...	...	13.63	3.74
Johore, Johore Bahru	...	..	...	88.03	73.09	...	...	...	...	...	...	8.81	2.60
Singapore, Kandang Kerbau	1015.56	...	83.1	88.2	73.6	...	78.53	.782	...	81.76	Calm	3.44	.90
Malacca, Durian Daun	1018.1	131.	83.	90.	72.	18.	80.	.968	...	85.	N.W.	9.52	2.00
Negri Sembilan, Seramban	...	152.	81.3	90.8	72.4	18.4	77.8	.825	73.1	78.9	N.W.	9.33	2.00
" Kuala Pilah	...	148.7	81.2	89.5	70.2	19.3	77.2	.856	74.5	81.2	...	9.25	3.66
" Port Dickson	...	151.7	81.1	86.8	76.7	10.1	77.5	.872	75.1	80.1	...	8.92	2.85
Selangor, Kuala Lumpur	...	153.8	80.5	88.3	72.3	16.	76.6	.844	74.	81.	S.W.	12.83	2.69
" Klang	...	...	79.	84.4	74.	10.4	75.5	...	...	...	...	10.53	.42
" Kuala Selangor	...	...	...	89.7	...	...	...	...	...	...	...	9.33	2.26
" Rawang	...	...	..	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	80.66	91.	67.	24.	77.34	.895	...	87.	...	23.14	6.49
" Ipoh	...	...	80.85	94.	68.	26.	76.12	.838	73.75	80.	...	10.55	1.53
" Taiping	...	...	80.14	91.	70.	21.	76.75	.876	...	87.	...	24.80	2.99
" The Cottage	...	...	...	...	...	...	...	...	...	...	...	28.43	2.99
" Parit Buntar	...	...	81.17	93.	71.	22.	77.11	.877	...	83.	...	19.65	2.99
Penang, George Town	1014.6	155.	80.3	99.	70.	29.	78.7	.940	70.5	86.8	N.W.	27.99	5.15
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	14.36	4.31
Perlis, Kangar	...	...	...	87.54	73.51	..	...	...	...	...	...	.56	.10

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of November, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	142.0	82.7	89.13	73 63	15.50	75.6	.754	70.8	67.	...	8.59	1.47
Pahang, Kuala Lipis	...	...	79.9	88.4	69.7	18.7	75.8	...	...	...	...	10.66	2.53
Johore, Johore Bahru	...	..	...	88.03	75.43	...	...	...	...	...	...	11.02	2.95
Singapore, Kandang Kerbau	1130.1	...	80.8	88.2	73.5	...	77.3	.787	...	86.1	Calm	6.58	1.90
Malacca, Durian Daun	1018.	131.	82.	90.	71.	19.	79.	.965	...	83.	N.W.	11.96	3.19
Negri Sembilan, Seramban	...	151.	81.5	91.	72.5	18.5	77.	.842	74.1	78.8	N.W.	5.04	1.22
„ Kuala Pilah	...	149.5	81.1	88.8	70.5	18.3	77.4	.869	75.06	81.6	...	9.23	2.68
„ Port Dickson	...	152.6	80.8	85.8	74.1	11.7	74.3	.889	75.5	80.8	...	9.96	1.89
Selangor, Kuala Lumpur	...	153.1	81.2	88.3	72.8	15.5	75.	.848	74.2	80.	N.E,	3.65	.32
„ Klang	...	...	80.1	84.7	74.4	10.3	76.5	...	...	...	...	7.51	1.44
„ Kuala Selangor	...	...	...	90.6	...	...	...	...	...	...	...	6.64	1.80
„ Rawang	...	...	...	...	...	...	...	...	...	...	...	...	...
Perak, Teluk Anson	...	...	81.42	91.	67.	24.	77.55	.894	...	83.	...	14.21	4.65
„ Ipoh	...	...	80.84	93.	69.	24.	76.23	.843	70.82	80.	...	13.19	2.83
„ Taiping	...	...	80.66	92.	72.	20.	76.96	.877	...	85.	...	12.28	2.16
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	19.84	2.56
„ Parit Buntar	...	...	81.48	92.	70.	22.	77.19	.876	...	83.	...	10.74	1.85
Penang, George Town	1009.9	156.	83.	98.	70.	28.	79.5	.940	69.8	83.	N.W.	14.76	4.60
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	8.88	2.85
Perlis, Kangar	...	...	...	86.13	78.20	12.93	...	...	...	...	...	.50	.13

Abstract of Meteorological Readings in the various Districts of Malaya for the Month of December, 1923.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	...	78.8	85.41	73.51	11.90	74.3	.761	71.1	77.	...	22.45	3.06
Pahang, Kuala Lipis	...	...	75.1	86 3	72.0	14.3	75.1	...	...	...	...	13.96	1.94
Johore, Johore Bahru	...	...	...	85.87	72.74	...	...	...	...	...	...	9.04	1.68
Singapore, Kandang Kerbau	1014.1	...	81.36	86.7	72.6	...	77.	.782	...	86.1	Calm	8.42	1.96
Malacca, Durian Daun	1018.3	127.	82.	89.	71.	18.	78.	.942	...	84.	N.E.	6.65	1.57
Negri Sembilan, Seremban	...	150.	80.8	90.7	72.7	18.	77.1	.871	75.2	83.	N.W.	6.95	.73
„ Kuala Pilah	...	137 8	79.3	85.2	69.9	15.3	76.6	.858	74.4	86.44	...	8.68	1.65
„ Port Dickson	...	151 5	80.3	86.4	73.6	12.8	77.2	.864	74.7	81.7	...	10.47	1.69
Selangor. Kuala Lumpur	...	146.1	80.8	86.9	72.9	14.	76.7	.843	74.1	81.	Calm	11.32	.93
„ Klang	...	...	79.1	84.2	74.2	10.	...	...	...	...	...	10.05	1.87
„ Kuala Selangor	...	...	...	89.	...	...	...	...	...	...	...	12.07	3.35
„ Rawang	...	...	...	...	...	..	...	...	...	..	...	...	...
Perak, Teluk Anson	...	...	81.18	91.	67.	24.	77.66	.900	...	85.	...	15.66	4.25
„ Ipoh	...	...	80.50	96.	70.	26.	75.93	.836	73.35	80.	...	8.43	3.78
„ Taiping	...	.	80.68	91.	71.	20.	77.22	.891	...	87.	...	17.17	1.81
„ The Cottage	...	...	...	...	...	...	.	...	...	...	..	12.28	2.05
„ Parit Buntar	...	...	81.46	92.	70.	22.	77.38	.884	...	88.	...	7.24	2.51
Penang, George Town	1008.4	155.	83.3	94.	70.	24	78.7	.931	70.1	82.6	N.W.	4.70	.94
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	5.58	1.43
Perlis, Kangar	...	...	...	86.00	72.61	13.39	...	...	...	...	...	.21	.05